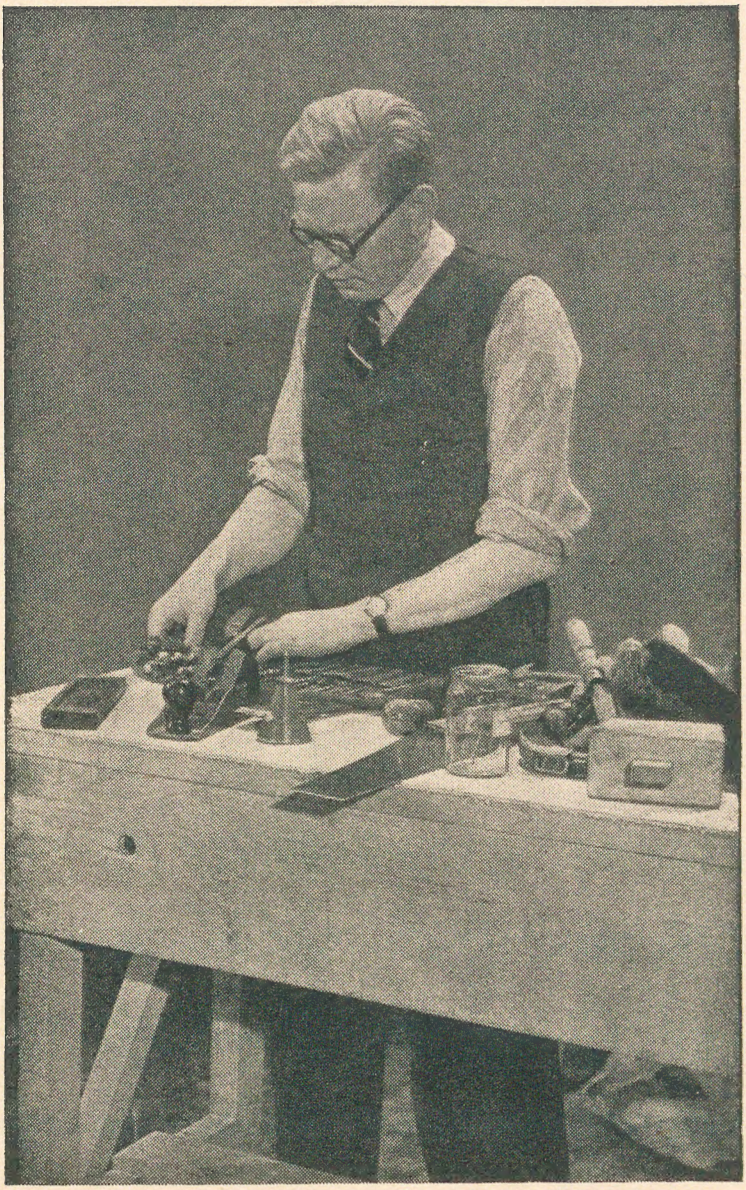
Craig Missingham
from my father.

MATTHEW'S CYCLOPAEDIA
of the
HOME



The Editor, during a television demonstration of tools.
Alexandra Palace, 1948

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MATTHEW'S CYCLOPAEDIA
of the
HOME

HOW TO KEEP YOUR HOUSE
IN GOOD REPAIR

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VOLUME I

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FOREWORD

The publication of these volumes brings to fruition a plan which I have cherished for a number of years. It has been my desire to see produced a really comprehensive work for the man who, by choice or necessity, finds himself responsible for the maintenance, repair and decoration of his own house. The need for such a work has been made very evident to me in the great number of letters I have received from listeners, readers and viewers of my own talks, articles and demonstrations over the last ten years.

How far this need has been met must be judged by the reader, but I, as Editor, must record my thanks to the team of expert contributors who have worked so hard and taken such interest in its preparation and production.

In this connection it is a real pleasure to pay especial tribute to the fine work of Mr. Edgar Lucas, A.I.A.A., and to Mr. Barnard Way. Mr. Lucas's own contributions are models of interest and clarity, and his invaluable suggestions have played a great part in the preparation of the work as a whole.

Mr. Barnard Way's illustrations throughout the volumes are no mere "technical drawings" slavishly following the text, but have an individual quality which renders them a direct contribution to the reader's interest and enjoyment.

May I in conclusion try to forestall one possible criticism? It will be found that certain passages are devoted almost entirely to such subjects as the history of the British house, the structure of the house, and to explanation of the functions of its equipment. These passages may contain little or none of the usual "how to do it" instruction. They are, however, in my opinion, extremely valuable in helping towards an understanding of the house both as a structure and as a machine for living, and that understanding is the essential basis of intelligent maintenance by the owner.

I hope that the work as a whole will be successful in fulfilling the intentions of the Publishers, the Editor and the Contributors in fostering that pride of possession in the house and the home which is traditionally a part of the British character.

W. P. M.

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SECTION I

THE HOUSE

CHAPTER I

HISTORY AND DEVELOPMENT

It is both useful and interesting to know how the house developed in Britain. Useful because such knowledge enables you to repair and extend houses and cottages of the traditional periods in an appropriate and sympathetic manner, and also to date them with reasonable accuracy. Interesting because it is an exciting story of human endeavour.

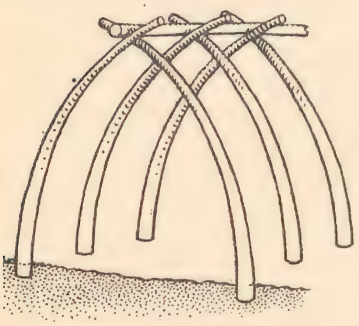
The earliest dwellings were caves and huts. The huts were constructed of curved branches, some to a conical and others to a rectangular shape, with brushwood woven between the branches or ribs. Some were covered with turf and some with mud. This type of construction is still used by primitive communities—and a very neat and weathertight job they make of it. Many readers will be surprised to learn that there are plenty of mud-walled cottages in Britain today—notably in Devon where the material is called cob. Damp earth is beaten down in layers and when finished the wall is whitewashed to protect it from the weather.

The early cottage

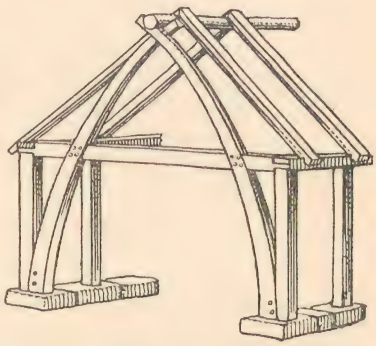
From the hut the early timber cottage developed. In its simplest form each end was framed with a pair of curved timbers called crucks, and they supported a horizontal ridge pole (or "roof tree," as it is still called in country places). The side walls were framed with vertical timbers resting on stone pads. These posts were joined at the top by a horizontal wall plate which served also to secure the feet of the rafters. The rafter heads met over the ridge pole. There are still a few cruck-framed cottages in existence.

In districts where stone was found near the surface it was

easier to build the walls of rough stone blocks, laid dry but with the gaps filled with mud. The roof was covered with timber pole rafters, brushwood and turf.



Cruck timber frame of early hut



Early timber frame cottage with crucks at the end

FIG. 1

As agriculture developed it was found that straw thatch made a cleaner and more weather resistant roofing. All through the ages you find this searching for something better.

Half-timber

Many districts of Britain have houses and other buildings of what is generally called half-timber construction. In districts where the timber has been painted black or tarred it is called "black and white" construction—the panels being plastered and whitewashed. As Britain was once almost covered with forests it was possible to cut the timber for a house on or very near the site. At first the logs were placed close together to form a solid timber wall—as is still done in parts of Canada and Northern Europe. As clearings were made and timber had to be fetched from a distance, this method was found too wasteful, so the timbers were roughly squared with the adze and narrow spaces were left in-between. These panels or spaces were then filled with wattle and daub (a rough lathing of twigs covered with mud). There is still plenty of old wattle and daub about, though most of it is a recent replacement. Later on, lath and plaster and also brickwork were used in filling these panels.

As the clearings increased it became necessary to use timber with greater economy still. So the posts were spaced 2 ft., 3 ft. and even 4 ft. apart and nogging or transom pieces were placed to give lateral stiffening. Then it was found that the best way

to stiffen a framing is by placing diagonal members at the corners. In some districts diagonal framing developed—in others square framing was preferred. It is interesting to notice local differences.

As timber framing developed, the skill of the carpenter increased. He held the timbers together with mortice and tenon joints, pegged or draw-bore pinned—the holes being slightly out of line so that when the oak pin was driven home it pulled the tenon tightly into the mortice.

Stone

From the unhewn blocks of the stone hut, men developed the art of working stone. First, roughly squaring it, then learning how to carve it into ornament and finally how to work it to accurate dimensions. You can follow this development in many old stone villages. The method of working the stone depended on the relative hardness. In Cornwall and Scotland the hard granites are roughly squared and only rarely highly finished or carved. In the limestone districts, such as the Cotswolds, and the sandstone districts, which are scattered over England, you will find finely-shaped mouldings and intricate carving. The doors have moulded jambs and canopies on stone brackets. The windows have chamfered or hollowed mullions and transoms with dripstone or hood mouldings over to prevent rainwater running down the wall and the window.

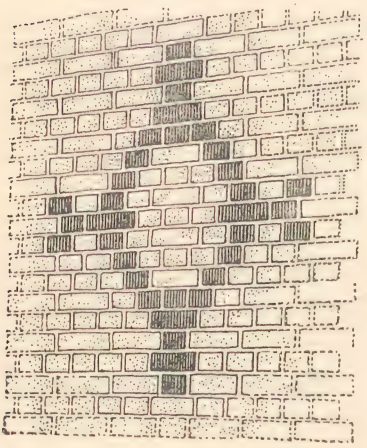
These stone details blend the practical and the artistic perfectly. Mouldings and copings were designed to shed rainwater, canopies and cornices to shelter doorways and walls, and every detail has some practical basis. This is why the old architecture is so difficult to copy by modern people who see only the prettiness and fail to grasp the essential commonsense and practical craftsmanship of the original.

Brick

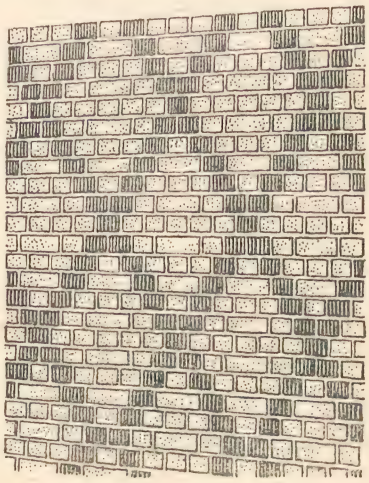
The crafts of brickmaking and brickwork were brought to Britain by the Romans (you can still see their brickwork in the remains of Roman villas), but it was lost and not reintroduced until the fourteenth century. As the great forests were cleared, timber became in short supply in many districts. This shortage

led them to quarry stone more extensively, and where clay was found they made bricks.

Old bricks may be identified partly by their irregularity, partly by the weathered tones and partly by their thickness



Brickwork pattern in dark header bricks



Diaper pattern in dark headers

FIG. 2

which rarely exceeded $2\frac{1}{4}$ in. It was not until the early nineteenth century that bricks as thick as 3 in. and $3\frac{1}{4}$ in. were used.

Brick craftsmanship in houses of the traditional periods is distinguished by many charming details. There is the dogs-

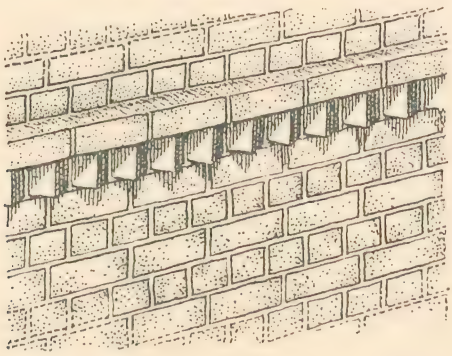


FIG. 3. BRICKWORK DOG'S TOOTH COURSE WITH PROJECTING COURSE ABOVE IT.

tooth course (see Fig. 3), the ornamental panels in herringbone and other patterns and a wealth of detail in moulded brick. The medieval brickwork is rather coarse with thick joints, but in the early eighteenth century a lot of work was done with rubber

bricks, which are rather soft and so can be rubbed with stones to exact dimensions. These rubbers were laid with very thin joints. They could also be carved, and shaped to form arches.

Other materials

Flint is found in some districts of southern and eastern England. It breaks into rough rectangular shapes about the size of a brick. The old builders often used them in conjunction with brick—brick courses being used to bind or strengthen the flintwork.

Thatch has been used in all the straw producing districts for hundreds of years, and there are still country craftsmen whose work is as good as their fathers'. In the clay producing districts tiles were made as well as bricks, so you find tiled roofs on brick houses. In Wales, Scotland, Cornwall, Westmorland and parts of the North, beds of slate were found in a stratified form which enabled it to be split into thin slabs suitable for roofing. On the Cotswolds, in parts of Dorset and in other limestone districts some of the stone also split easily into slabs—though thicker than slates—and were used for roofing. The old method of fixing was to cut two holes and wedge oak pegs into them so that the slate or slab could be hung on battens.

Planning and design

From the one-roomed hut or hovel the first development was to put a floor in just under the roof timbers. This gave an attic to which access was gained by a ladder. Then the height of the attic was increased to give better headroom and a staircase fixed instead of a ladder.

The ground floor was then extended to give two rooms—one being a working kitchen and the other a sitting-room. There you have a plan type which persisted for centuries. You can find examples in every district of Britain. They have large open fireplaces with massive chimneys (the older the cottage, the bigger the fireplace and chimney).

The manor houses and larger mansions of the twelfth to fifteenth centuries were modelled on the domestic accommodation of the medieval castle. There is a large high hall in which the lord of the manor not only lived his family life, but conducted the business and dispensed the justice of the manor. At

each end of the hall is a double-floor portion containing the private apartments of the family.

Then we have the old farmhouses which started as large cottages and were later extended. In many of them you can pick out the old from the not-so-old and the recent. Usually the rooms are larger and the headroom greater than in the cottages. Here and there you may find an old manor house, priests' house or small mansion used as a farmhouse.

Traditional architecture

Our traditional architecture falls into two main divisions: Gothic or Medieval and Classic or Renaissance. The sixteenth century may be taken as the intermediate or meeting period when Gothic design was dying and the Renaissance gradually displacing the old vernacular of design.

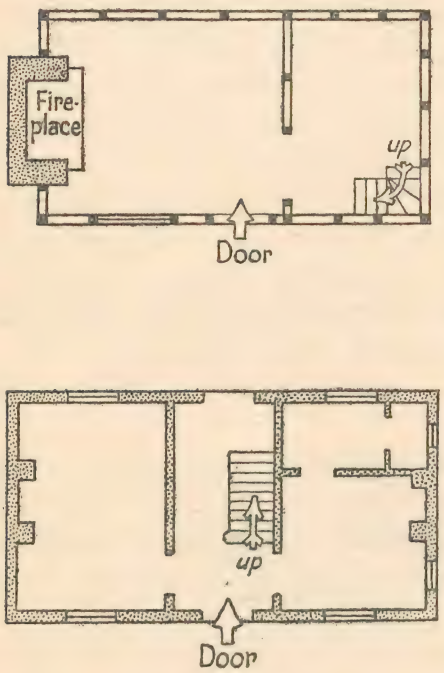


FIG. 4

Top: **Ground Floor Plan of typical medieval cottage with timber walls and wattle and daub panels**

Bottom: **Ground Floor Plan of Georgian cottage with brick walls**

Gothic architecture is distinguished by the pointed arch and the buttress in stone and brickwork, and by half-timber with wattle and daub panels. There are a few stone, timber and brick houses of the true Gothic age still standing, though most half-timbered houses and cottages date from the late sixteenth century and the early seventeenth.

Many of our historical mansions belong to this age. It comprised the Tudor period (1509–1558), which was the last phase of the true Gothic. The Elizabethan period (1558–1603) during which the classical Renaissance mingled with our older Gothic in a clumsy but vigorous kind of design. And the Jacobean (1603–1625) which contains with the growing vigour of the Renaissance the last traces of the Gothic.

The Renaissance in Britain developed rapidly after the first

quarter of the seventeenth century. It is distinguished by the use of columns of the classic orders with a balanced and symmetrical system of planning. A Renaissance mansion or even small house usually has the entrance in the middle with tall sash windows on each side. A Gothic house has no such symmetry.

The seventeenth and eighteenth centuries gave us a characteristic house plan (see Fig. 4) with the hall in the middle and rooms on each side. This was popular because it enabled the elevations to be balanced in all their parts, and it also gave an orderly plan arrangement. Until quite recently this type of plan was considered a very good one and was copied by modern architects. A fine feature was often made of the entrance doorway. Even small cottages of this type may have a nicely moulded canopy on carved brackets, and the larger houses have richly ornamented porches with columns and cornices.

The Renaissance survived until the industrial revolution killed it in the early years of the nineteenth century. It covers every sovereign from Queen Elizabeth to Queen Victoria. It is subdivided into periods named after the sovereigns, with the exception of the earlier part covered by the seventeenth century. Then followed: the Queen Anne period (1702–1714), the Georgian period covering the reigns of the first three Georges (1714–1820). The regency and reign of George IV is usually called the Regency period, and is the last phase of the Renaissance except for the first few years of Victoria's reign.

In the last part of the eighteenth century and the early part of the nineteenth our towns and cities rapidly expanded, and for the first time we find speculative house building on a large scale. The constructional standard was not always good but architecturally it was of high merit. Most of it was in the form of long terraces or blocks with brick walls covered with plaster or stucco and oil-painted cream. You may find many of these houses in most of our older towns, but notably in London, Cheltenham, Bristol, Bath, Exeter, Leamington and Edinburgh. Each house had only a narrow frontage, but architecturally it was part of a large unified scheme. The plans are not satisfactory by modern standards as many of the houses have basement kitchens, the rooms though large are not well lit, and there are three or four floors.

The Victorian house

With the nineteenth century we come to an unfortunate development in our domestic architecture. As the Renaissance lost its vigour, architects turned to the Gothic styles for inspiration. The pointed arch, the buttress and the mullioned window were revived. Nothing could have been more out of place, as the industrial revolution was displacing the old hand methods and bringing a scientific basis to construction. The imitation was both absurd and mean. Planed pitch pine was used in place of adzed oak, matchboarding instead of panelling, thin wood mullions instead of stone ones, Welsh slates instead of tiles and thatch, and a variety of "Gothic" detail was reproduced in cast iron.

The Victorian middle class was rich and pretentious, and these qualities are reflected in their villas. But towards the end of the nineteenth century a few architects discarded this Gothic imitation and tried to revive the old crafts and the mingled Gothic and Renaissance vernacular of house design. In the early years of the present century this craft movement spread to small house design. It gave us some very pleasant if rather "arty" looking houses, but it took no account of the new machine age and for that reason was a costly and unsatisfactory method of building.

The house today

This is a machine age. Practically everything in a modern house is machine made. This does not prevent us going on building houses of a traditional type, but modern architects have come along with new ideas on planning and design. They have found that a house is much easier to run and more comfortable to live in if it is designed on functional principles—just as a motor car or aeroplane is designed. Many people are deeply attached to the traditional house and cottage types and dislike this functional architecture. But even they are impressed by the light, spacious and clean interiors with their excellent equipment. We will go further into this when we consider the prefabricated house (see p. 41). It is worth pointing out here that in making the best use of modern materials and methods we are doing just the same as our forefathers of the Renaissance and Gothic ages. They were not tied to tradition—they tried

to improve and develop—but the tempo of change in their day was much slower than it is in ours. Our problems are much more complex than theirs, and new materials and methods are devised almost daily to add new problems.

All this gives us a very fine opportunity, and we are still only beginning to tackle it seriously, so do not condemn the modernist house because some examples are silly or ugly. Such examples can also be found among traditional types.

CHAPTER II

EFFICIENCY AND DESIGN

We want our houses to stand up to the extremes of climate which we encounter in Britain, and to ordinary wear and tear, without giving serious trouble. Small defects may occur which are easily dealt with, but we strongly object to damp walls, frozen pipes, leaky roofs, smoky chimneys, draughts and all defects which are due to inefficient design or construction. Now, let us examine the fundamentals of efficient design.

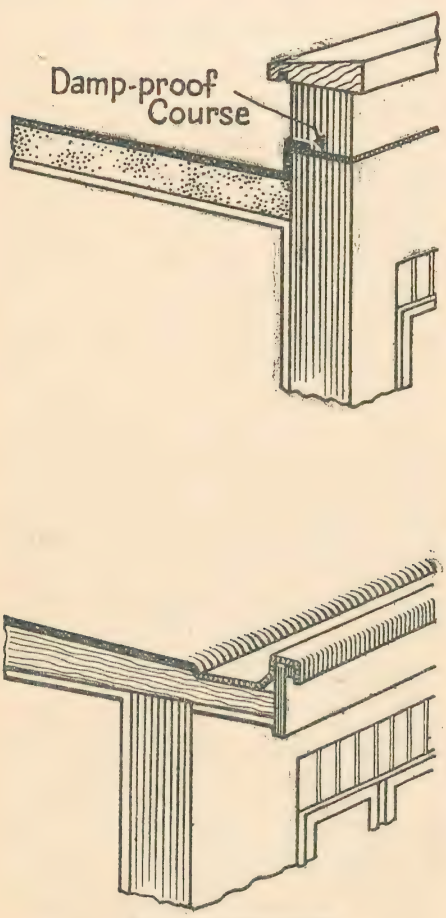


FIG. I. FLAT ROOFS

Top: The parapet wall has a damp-proof course to prevent rain soaking downwards

Bottom: The projecting roof protects wall from rain

Fundamentals

Briefly, we have to contend with rainwater, ground moisture, winds and extremes of heat and cold.

Walls are usually constructed of materials which absorb water by capillary movement through the open pores of the materials. It is important to understand the principle of the capillary movement of water. If you dip one end of an open tube of very fine bore into water, the water will gradually rise up the bore. Thus capillary movement takes place in spite of the force of gravity. A brick or a mortar joint contains fine pores or pockets and water creeps across these, just as it creeps up the fine bore

tube. It will creep through a wall of absorbent material in all directions—up, down and sideways.

With an ordinary solid wall, 9 in. thick, and bricks of average density, rainwater will penetrate the wall if the rain continues

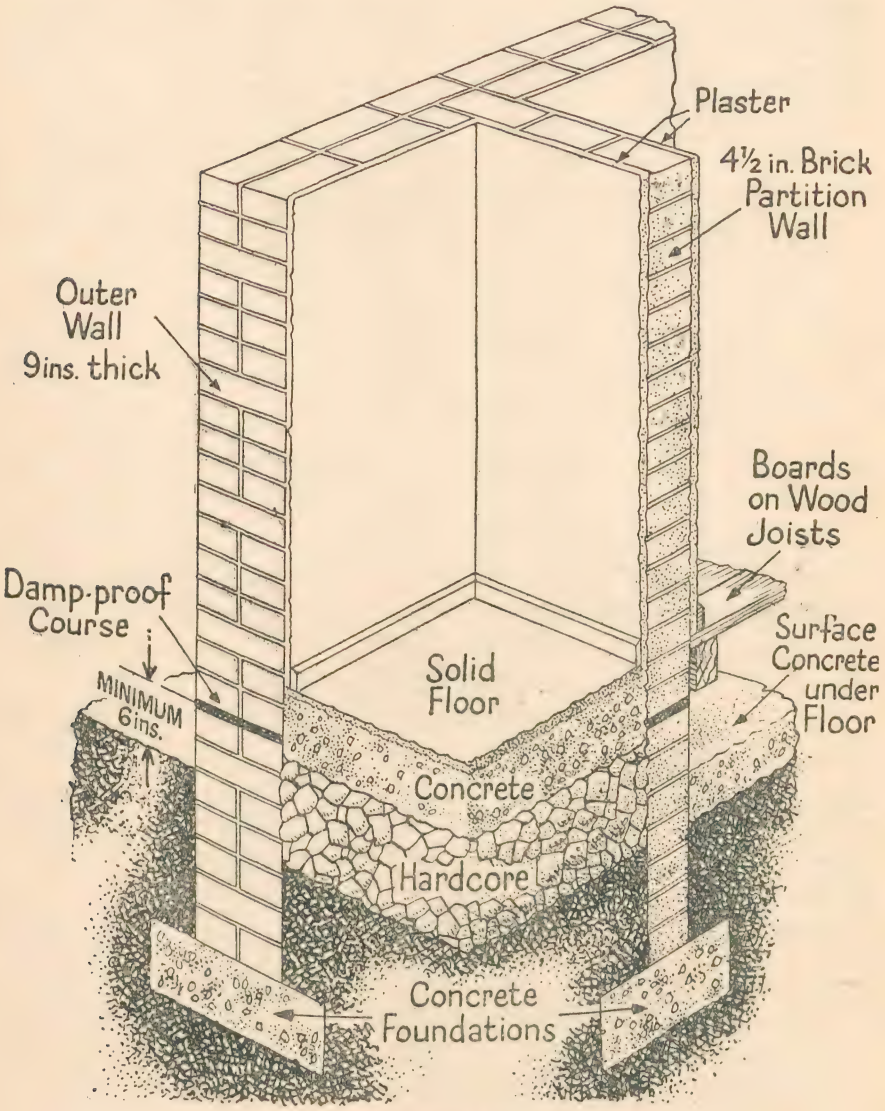


FIG. 2. SOLID WALL CONSTRUCTION

long enough. The period will depend on the relative exposure of the wall and the driving force (due to wind) of the rain. In a sheltered position 9-in. solid walls rarely admit damp, but what about the exposed position?

We can increase the damp resistance of the wall by adding an external or internal rendering, and we can prevent damp

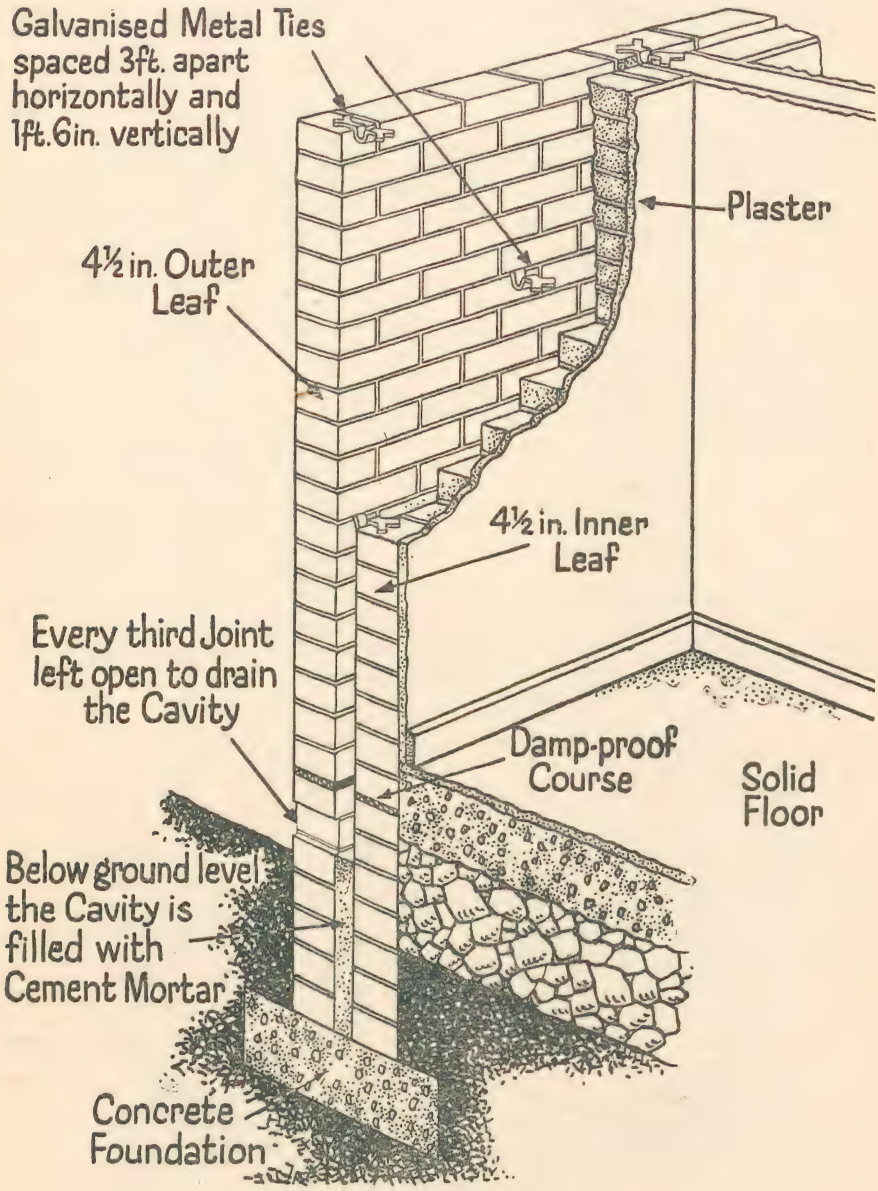

Galvanised Metal Ties spaced 3ft. apart horizontally and 1ft.6in. vertically
Plaster
4½ in. Outer Leaf
4½ in. Inner Leaf
Every third Joint left open to drain the Cavity
Damp-proof Course
Solid Floor
Below ground level the Cavity is filled with Cement Mortar
Concrete Foundation

FIG. 3. CAVITY WALL CONSTRUCTION

penetration by waterproofing the external rendering. But there are snags in this. Rendering often develops fine cracks, called "crazing," through which damp is admitted.

The cavity wall

If we build the outside walls in two thicknesses with a cavity between them, the outer leaf may be soaked with water but the inner leaf will remain dry. This sounds a simple and positive preventive system. But again there are snags.

The two walls must be bonded together with metal ties to give adequate strength. These ties are cranked or twisted so that water creeping across them will drip off in the middle. Unfortunately, as the bricklayer works, some of the mortar inevitably drops into the cavity, and some of the droppings catch on the ties. The mortar, being absorbent, will allow water to creep across to the inside wall. This can be avoided by taking certain precautions, the chief of which is to cover each course of ties with a wood batten which catches the droppings. The batten is then raised and cleared. Obviously this depends on the bricklayer being a careful workman.

Another difficulty occurs at door and window openings (jambs, heads and sills). These details must be so designed that water cannot creep across to the inner wall. If the cavity is closed with solid brickwork damp may penetrate all round the window or doorway. Fig. 5, p. 160, illustrates typical means of avoiding this.

If these precautions in design and construction are observed, the cavity wall will be damp-proof. It will cost a bit more than a solid wall but the extra cost is well worth while. If, however, you are having a house built in a sheltered position, a solid wall will probably be satisfactory.

Roof pitch and roofing

Here we have to consider two factors: relative exposure and the roofing material. Rain driven by strong winds may be blown up the lap of tiles or slates and so penetrate the roof. There are two ways of preventing this. If the pitch is steep enough and the lap adequate, the strongest wind will not drive the rain to the head of the tiles. Or we can have a relatively low pitch and use bituminous felt or waterproof building paper as an under-roofing, so that any rainwater blown up the laps will run down the felt or paper into the eaves gutters, as shown on p. 132.

The old method of preventing water penetrating the laps was to "torch" each course of tiles under the roof. Torching is a form of pointing in mortar. But this is not as good as underfelting. Moreover, torching can only be applied to clay tiles of the plain type. Underfelting can be used with any roof covering.

The cheapest way to apply underfelting is simply to lay it over the rafters before fixing the battens. It sags slightly between the rafters so a reinforced or untearable felt should be used. Sagging can be avoided and the insulation of the roof improved by nailing sawn boards on the rafters before laying the underfelt. The best method of all is to board over the rafters, then fix counter-battens up the roof, from eaves to ridge, and then fix the tiling or slating battens across them. Any water which penetrates the roofing then has a clear run between the counter-battens down to the eaves gutter. It is essential to have the underfelt projecting slightly over the eaves gutter to afford drainage.

Pitch

For plain clay tiles the pitch should be 45–59 degrees with a lap of 2½ in., or 35 degrees with a lap of 3½ in. For a pitch less than 45 degrees underfelting is advisable in all positions, and whatever the pitch and lap underfelting should be used in an exceptionally exposed position.

For interlocking clay tiles the pitch should be 35–40 degrees and underfelting is strongly advised as any slight misfit in the tiling may allow water to penetrate.

Slating should have a pitch of not less than 30 degrees with a 3-in. lap. Over 45 degrees the lap may be reduced to 2½ in. Wind-driven rain is less likely to penetrate the laps of slating than of tiling, but in an exposed position underfelting is advisable.

Prevention of frozen pipes

More attention is now being given to the protection of water pipes against frost. When water freezes, the solid ice occupies more space than the water, and this expansion puts great pressure on the pipe. If the pressure is sufficient to burst the pipe, no

indication will be given at once, but when the ice thaws water will pour through the crack.

The preventive is simply to ensure that the water in the pipes cannot be frozen in even the severest weather. Generally, there

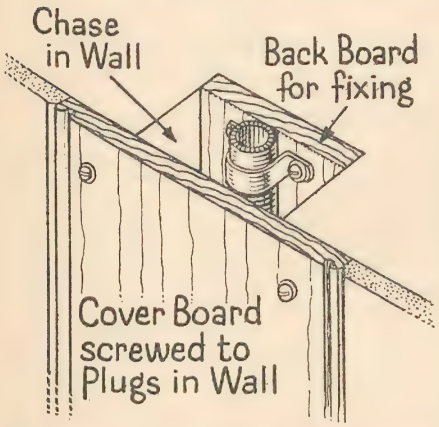


FIG. 4. PIPES IN A COVERED WALL RECESS. THE BACK BOARD GIVES PROTECTION AGAINST FROST

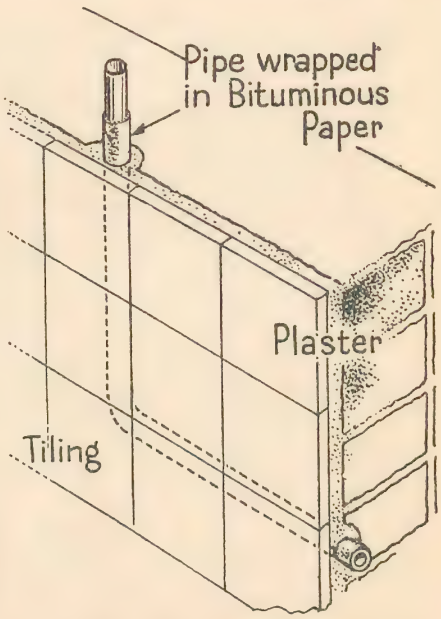


FIG. 5. PIPES CONCEALED BEHIND WALL TILING SHOULD BE WRAPPED IN BITUMINOUS PAPER TO ALLOW FREEDOM TO EXPAND. THEY SHOULD NOT BE PLACED IN COLD EXPOSED WALLS OR THEY MAY FREEZE UP

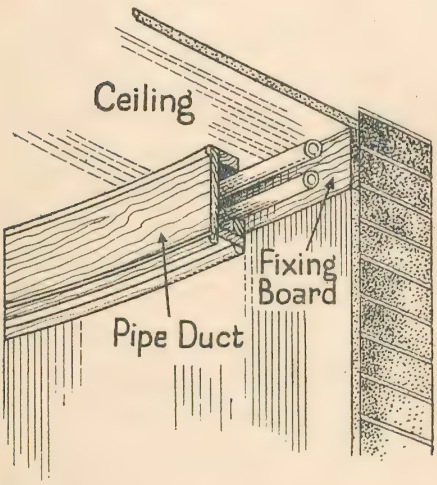


FIG. 6. PIPES IN A BOARDED DUCT ON A FIXING BOARD. THIS GIVES PROTECTION AGAINST FROST

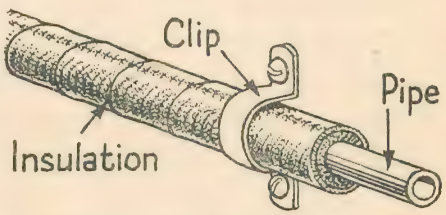


FIG. 7. INSULATION WRAPPING TO PROTECT A WATER PIPE FROM FROST

are two ways of doing this: the first, to place the pipes as far as possible in the warmest parts of the house. And second, to cover with insulating material those pipes which must be placed on outside walls and other cold positions.

The service pipe from the main should be laid at least 2 ft. 6 in. down in the earth to be beyond the reach of ground frost. If

possible it should be brought up an inside partition wall instead of an outer wall. If it is near a fireplace so much the better.

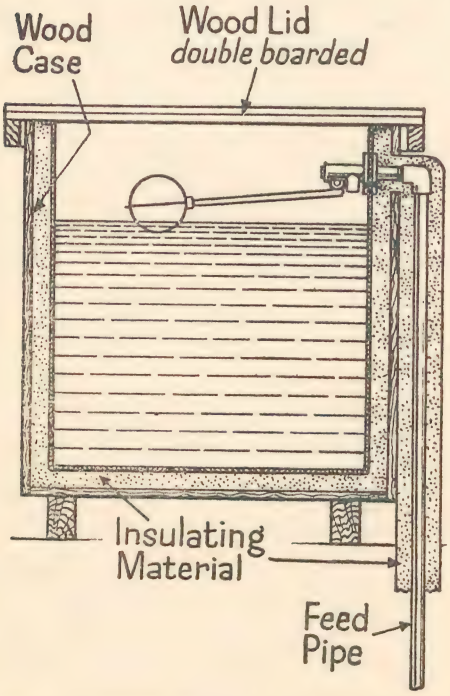


FIG. 8. A WATER CISTERN AND FEED PIPE IN A COLD POSITION SHOULD BE COVERED WITH INSULATING MATERIAL FOR PROTECTION AGAINST FROST

If brought up an outer wall it should be fixed well away from windows and doors. A wood board should be plugged to the wall and the pipe fixed to it. Pipes should never be fixed direct to walls. If the pipe is on an exposed outer wall it should be wrapped with insulating material or cased in wood, the front wood strip being screwed in position so that it is easily removable.

Roof spaces are often very cold owing to draught blowing up the laps of tiles or slates and through slight gaps at the eaves. Pipes and tanks in roofs should be protected by covering with insulating material. Expansion pipes should not be taken through the roof to discharge into the open air as the outlet may freeze up with disastrous consequences.

Waste pipes should be taken down to ground level inside the house, where local byelaws allow. It is quite unnecessary to have waste pipes outside where they are bound to freeze up in winter if there is a dripping tap.

CHAPTER III

SPECIAL TYPES OF HOUSE

THE 40–80-YEAR-OLD VILLA

Victorian villas are mostly well built and spacious. But after forty years or so any house, however well built, needs careful maintenance if decay is to be prevented. Most villas of the last half of the nineteenth century are ugly, belonging as they do to the tasteless Gothic revival already described (see p. 8). Some early examples of the period are of the Georgian style and quite pleasing in appearance. Those of the late nineteenth and early twentieth centuries are mixed. A few are quite good, but most are overloaded with ornamental trimmings of a kind which does not please the modern eye.

We have to deal then, with problems of maintenance, repair and modernization.

Maintenance

If the house is in good condition it only remains to keep it so. Neglect will slowly but surely produce small faults which if left will deteriorate into serious defects. The golden rule in maintaining any property is to attend to small faults as soon as they appear. Much money and trouble can be saved by doing so.

Wood and iron must be protected from the weather. Once rot and rust set in deterioration cannot be stopped. It is useless to paint over rotten wood, as the rot will continue underneath the paint, and it is useless to paint over rusted iron as the rust will scale and push the paint off. Hence the importance of regular repainting. How often should the exterior be repainted? Opinions vary, and the fact is that much depends on the quality of the paint and brushwork. Good external paintwork may successfully resist the weather for five or six years. Work of poor quality may blister or crack in less than twelve months. As soon as general defects appear the whole of the

surfaces should be repainted, after removing any defective paint, as described on p. 60, Vol. II.

Mortar pointing protects walls from the weather, just as paint protects wood and iron. Most Victorian houses have walls of 3 in. or 3¼ in. red bricks with stone dressings. The joints are thin and the brickwork laid in a strong hydraulic mortar. In these days of strong Portland cement mortars you may think that a lime mortar is poor stuff. A strong hydraulic lime mortar, while not as hard as a modern cement one, is in some respects better. It does not crack or craze with shrinkage and it yields better to slight settlement.

You may find some of the smaller villas of the speculative type have brickwork in a soft lime mortar. So soft that it crumbles when touched and appears to be nearly all sand. Certainly this cannot be described as good mortar, but provided the walls are dry and there are no settlement cracks, the walls will be quite safe and sound if the joints are kept properly pointed.

Mortars are discussed in Section II. But it is worth mentioning here that old houses should not be pointed in strong Portland cement mortars, particularly if the bricks are rather soft. Effloresence and damage to the bricks may result if cement mortar is used. It is better to use a lime-cement mortar which will set to approximately the same strength and density as the bricks. If the bricks are very dense and strong you may safely use a Portland cement mortar—but do not make it very strong.

Rot in woodwork,

Rot in woodwork, particularly wood floors, is a serious risk in old houses, though the villas of the later Victorian period usually have good damp-proof courses and well-ventilated ground floors. If you have just taken possession of an old house it is advisable to take up a floor board, using a panel saw to cut through the tongueing, to see the condition of the timber under the floor. The presence of dry rot is, however, fairly obvious when it is well advanced as floor boards will break through if stamped upon, and there is usually a musty smell. Dry rot is described in Chapter XVII. Preventive measures should be taken in an old house. Dryness and ventilation are the two essentials.

The holes in air bricks must be kept free from accumulations of soil and dust. A rod should be poked through the holes to clear them. If the ground is dug up against the wall, take care not to throw it up to cover the air bricks or the damp-proof course. There is a byelaw to the effect that a damp-proof course must be at least 6 in. above the ground or paving level. But you will find many cases where it is actually less. We may take 3 in. as a minimum for safety in an old house.

When pointing brickwork, do not forget to point the joints below the damp-proof course. In fact it is advisable to dig the ground out and point down to the course below the ground. This will help in keeping the wall dry below floor level.

Make sure that there is through ventilation, so that air can pass right under the floor. If you alter or extend the house do not cover up any air bricks.

Cracks and crevices

If these occur in external walls and are allowed to remain the weather will penetrate and cause dampness. You may find a few in an old house, but they are not serious provided that they are not extensive enough to weaken the wall and do not continue to open. Slight cracks may be due to shrinkage movements in the wall or subsoil. Point them in lime-cement mortar, forcing the mortar deeply into the crack.

The interface between door and window frames and the wall jambs is a weak spot in all buildings. The wood shrinks a little, and even if the gap has been pointed in mortar the mortar will not adhere to the frame. You will probably find that the gap is almost covered by a small wood moulding nailed on after the window or door frame was fixed. But it leaves a small space through which the rain is driven by the wind. These mouldings should be prised off and the gap pointed with a bituminous mastic. There are several proprietary makes, and any ironmongery and paint shop will supply you. The mastic is black and should be carefully forced into the gap with a knife or small trowel, taking care to keep it off the paintwork. The mastic retains ductility—it does not set hard and does not shrink—so that it permanently seals the gap.

It can be used for sealing any slight gap or crack. If you find

that water is getting in through defective flashings round chimneys or parapets or through cracks in old lead or zinc roofings, mastic can be used to seal the cracks and crevices. If the gap is more than $\frac{1}{8}$ in. wide cover it with a strip of canvas bedded in mastic and then spread mastic over the surface.

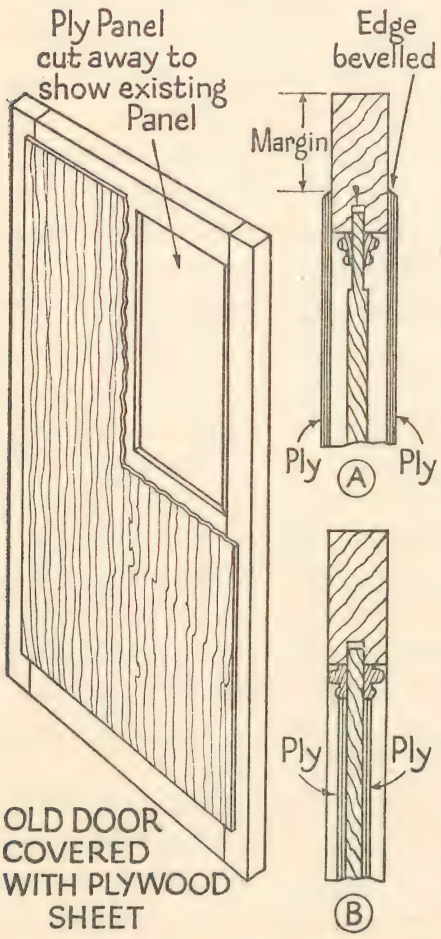


FIG. 1. RENOVATING OLD DOORS

A: Detail showing covering of whole door with plywood sheet

B: Detail of panels only covered with separate plywood sheets

Modernizing

The worst points about a Victorian villa are usually the windows, doors, joinery and external features. They are generally ugly and heavy looking. Doors can be taken off and new ones fitted, but a cheaper treatment is to convert them into flush doors by covering with plywood. You can use birch-faced ply and stain it, though oak will look better of course. If the old door has any projecting mouldings, these must be planed flush. It will be necessary to move the hinge fixings slightly so that the rebate of frame will accommodate the extra thickness of the door. An alternative which will avoid this is to cut the plywood panels about 2 in. short of each edge, as in Fig. 1.

The hall of a Victorian villa may be narrow and dark. The darkness is largely due to the stained glass vestibule screen. The stained glass should be removed and either sheet glass substituted or leaded lights with clear or slightly obscured glass. In some cases it will effect a great improvement if the whole screen is removed and a new one made and fixed. The new screen should have full length side lights and the vestibule

door should be of the casement door or French window type.

In most Victorian villas the windows give enough light, but they are ugly. The bay windows are particularly bad. The only satisfactory treatment is to have the windows removed and new ones fitted, and if only three or four are so treated the cost will not be great. The work could be done by an experienced handyman. To make a watertight job, use bituminous mastic in the interface between frame and opening—that is, along jambs, heads and sills.

In some rooms you may find three or four narrow windows separated by brick piers, which obstruct both light and view. It will be a big improvement to have these piers cut out and a wide window fitted. But this is a job for a builder, as the wall above must be underpinned and a wide lintel fixed.

Floorings may need renovation and repair. There may be oak boards in some rooms, but if they look grimy, through dust absorption, and the edges stand up as they usually do, they can be made to look as good as new by first planing down the edges, after punching down the nail heads, and then scraping the whole surface. You can buy a proper joiner's scraper at any good tool shop.

One of the worst defects in old floor boarding is the narrow gap opened between boards, owing to shrinkage. If the gaps are very narrow, fill them with plastic wood, after scraping and brushing away all dust. If they are more than $\frac{1}{8}$ in. wide it is better to plane narrow wood strips to fit, using a water-resistant glue to fix them.

The gap between skirting and floor, due to shrinkage, can be closed by nailing a small moulding over. Press the moulding tightly against the skirting but nail it to the floor, so that any further shrinkage cannot reopen the gap.

Tile and quarry floors may be in bad condition, and tessellated tile floorings are usually ugly. The cheapest treatment is to use a red floor polish or a floor paint. If the tiles are badly worn or broken it is advisable to take up the whole flooring, chip the cement bedding away and lay new tiles. This is beyond the average handyman and it is better to get a builder to do it.

If the boarded floors are of deal and in poor condition, though

free from rot, the best treatment is to have them covered with oak-faced plywood squares. These should be fixed with glue and panel pins. The old boards must be planed level and nail-heads punched down before fixing the plywood.

Plywood can be used as a border to carpet squares. This is an economical treatment and quite simple to do. Long sheets should be obtained so that not more than one heading joint occurs in the ply covering.

The exterior. If the house has a stucco covering, oil painted, to the exterior walls, it is very important to keep it properly protected by renewing the paintwork every three or four years. Old stucco consists of hydraulic lime material, which though fairly strong, soon deteriorates if the weather is allowed to get at it. Hence the importance of paint protection. Defective portions are easily repaired by mixing a lime-cement mortar (see p. 111) and applying with a steel trowel or wood float.

Many Victorian villas are of red brick with stone dressings. These materials in most cases have weathered to a dirty tone which is very unattractive. The dressings—sills, window and doorheads and mouldings—may be of soft stone which has crumbled away and looks shabby. Most people would like to freshen up such walls but do not know what to do about it. A colourwash or flat oil paint of cream tint is the cheapest treatment. Any defective pointing, brickwork or stonework should be repaired first. If the walling material is in bad condition it is better to have it rendered with a lime-cement mix. This is a job for the builder. The rendering can be finished with a coat of a proprietary coloured material (consisting of a special sand and pigment mixed with cement). If it is finished with Portland cement it should afterwards be painted with a cement paint. New Portland cement does not take oil paint well—it releases salts which cause the paint to flake off.

If you have new windows, as previously suggested, they will do much to smarten up the outside. If there is an existing porch of the typical Victorian type—all twiddlely bits and fret-work—it will improve the appearance to take it down and replace with a plain modern design.

If the walls are painted cream the woodwork will look best painted a shade darker—a primrose or stone colour. If the walls are painted white, cream will be just right for the

woodwork. Doors can be painted another colour—but keep it light in tone. Dark greens and browns make many of our houses look depressing. We need brighter colours.

THE COUNTRY COTTAGE

Country cottages and small country houses are not nowadays exclusively dwellings for country people. Townspeople buy them, some for use as week-end retreats, and some for permanent residences. One can now live in the country and work in the town if a car or good public transport is at hand.

Country cottages range from the very good to the shockingly bad. The very good are those which have already been modernized to some extent and are in good repair. The very bad may be ready to fall down.

Two essentials

If you are buying a cottage there are two essentials: the walls must be in reasonably good condition, and the roof must be watertight. Of course, the walls may need repointing and a few decayed bricks replacing, but as long as they are not badly cracked or bulging they can be put into good condition at reasonable cost. The roof may be rather uneven and let in a little water in driving rainstorms, but as long as the timbers are not rotten and the tiles or other roof covering not badly decayed, it too may be put right at slight cost.

Next in importance are the floors. If the ground floors are in very bad condition, they can be taken out and new ones put in. But if the upper floors are rotten, it is a more serious matter, as it may imperil the walls to take out the old floor joists—as well as being a costly job.

In short, a sound carcass is essential. Given this you can put right the smaller defects and modernize the place at a moderate cost. Much of the work can be done by an experienced handyman.

Dampness

Old cottages have no damp-proof courses to the walls. It does not follow that they are damp, but look for the signs. Rising

damp will discolour the inside decorations just above the skirting. The only sure remedy is to cut out brickwork in short lengths of a foot or two and insert a damp-proof course of slates in cement or blue brick—remembering that the damp-proof course should be 6 in. above the outer ground level. This is not an easy or a cheap job. You can try methods of keeping the ground around the wall dry, or almost dry. Get the ground out round the outside of the walls to a depth of about 18 in. and fill up with stones or broken brick. Then bank the surface up slightly and cover with concrete slabs so that they slope away from the wall. This will prevent water settling round the foundations. There is still the possibility that rain may splash up from the slabs and soak the lower part of the wall. To prevent this render the plinth in cement mortar for about 12 in. from the slabs. This treatment should be effective if the site is not exceptionally damp. (See Fig. 2.)

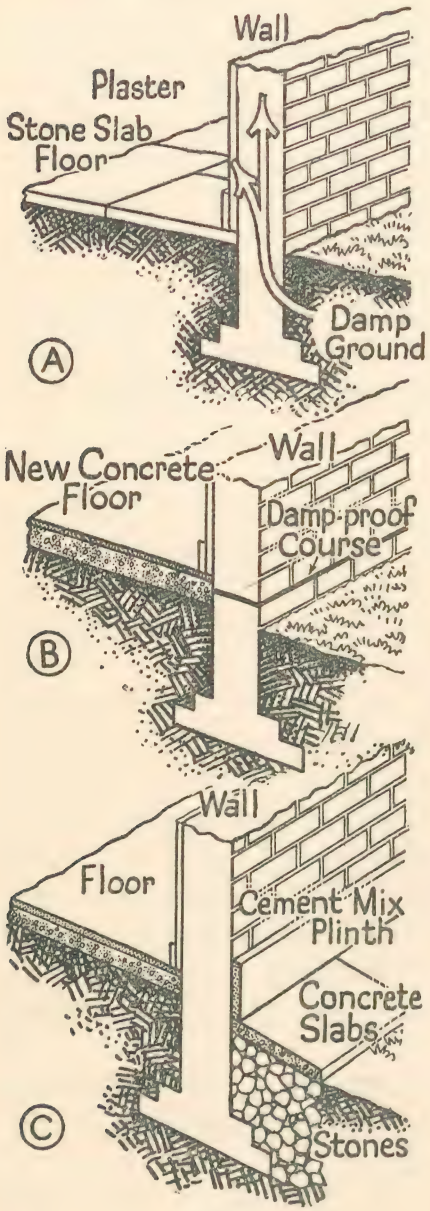


FIG. 2

A: Section through old cottage wall showing damp rising from ground

B: Damp-proof course inserted in wall and new concrete floor

C: Instead of damp-proof course ground around foundations is kept dry by taking out earth and filling with stones, then covering with concrete slabs laid to slope away from wall

Walls

If the mortar joints are in poor condition, repoint in lime-cement mortar, as described in Section II. You may find that damp comes through one or more walls which are exposed to driving rains. Suitable treatments are described in

Section II, but do not spoil a nice old cottage by rendering in cement. It is better to use a transparent waterproofing liquid or cream flat oil paint. In some cases an interior treatment may be advisable.

Damp may be coming through the gap between frames and walls, so point these with bituminous mastic, as already described (see p. 19).

Roofs

If the roof is in good condition, keep it so by replacing any tiles or slates that slip, without delay. Repair any defective flashings round chimneys and parapets. Old tiled roofs usually admit water in heavy driving rain—it is blown up the laps. The old method of dealing with this was to "torch" the underside. That is, to point the gaps at the heads of the tiles, under the roof, with mortar. The modern method is to lay underfelting under the tiles, but you cannot do this with an old roof unless you strip it. If you torch the underside, use a rather weak lime-cement mortar and work it well into the gaps. But never point the gaps outside—sooner or later the mortar will shrink and crack, and the treatment spoils the look of the roof. It is true that you may see old tiled roofs covered with a mortar slurry as a waterproofing treatment, but it is unsightly and by no means a sure cure. Red bituminous preparations are also used for such all-over treatment. These are more effective than slurry, though hardly less unsightly.

One cause of leaky roofs in old cottages is the unevenness of the roof owing to the sagging of roof timbers. The timbers may be rotten and nails may have rusted away. Continued movement of the roof structure will open gaps in tiling or slating. If the timbers are sound you can arrest the settlement by placing struts and ties at suitable positions (see Fig. 3) and by renailing.

If the timbers and battens are rotten nothing short of a new roof will be satisfactory. The construction of a plain gabled roof for a small cottage should not be beyond the skill of a good handyman. Take careful measurements and prepare the timbers in advance. This will save time once the old roof has been removed. A period of fine weather is necessary for such a job, and, of course, some assistance will be needed.

Old tiles are nibless and depend on nailing to hold. Use copper or good composition nails. Slates must, of course, be nailed. If new tiles are used choose the darker tones, preferably of the sand-faced type. Smooth red tiles look very raw on an old cottage.

If you have a thatched cottage try to find a local thatcher to keep it in good condition, and if it is badly decayed have it re-thatched. It is not very costly and makes a well-insulated roofing. It is true that tiles and slates are more durable and are fireproof, but additional carpentry is necessary to prepare the roof for these coverings.

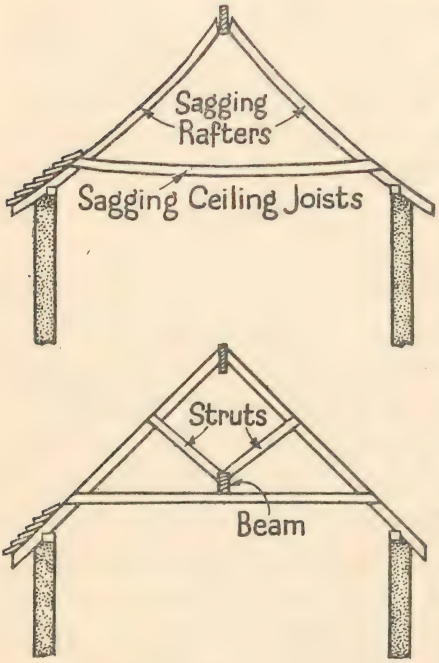


FIG. 3

Top: Sagging roof timbers

Bottom: Struts supported on beam. The beam rests on end and cross walls and ceiling joists are nailed to it

Thatch can be given a considerable degree of fire-resistance by soaking the straw (before laying) for a day or two in the following solution: ¾ lb. alum, ¾ lb. copper sulphate, 50 gals. water. A large tank or tub is necessary and the straw should be loaded down to keep it immersed. The thatched roofing should be treated with this solution every four or five years, as rain gradually washes it out of the surface straw.

To prevent rats and birds entering a thatched roof, fix wire-netting to eaves and verges.

Flues

The fireplaces and flues in many old cottages are very large and were built to burn logs or peat. The old open hearths look picturesque but may encourage down-draught. It is advisable to fit a modern grate—the old brick fireplace surround can be preserved. If the flues are bigger than 9 in. by 9 in. they will probably need restricting just above the fireplace to prevent

down-draught, and may need restricting all the way up—which means that one side must be cut out in sections while brickwork is built into the old flue.

THE "HOUSING-SCHEME" HOUSE

Houses built by speculators vary widely in quality. Houses built by local authorities (some of which are sold to occupiers) are generally of better quality, though the interior equipment is not usually as good. Perhaps the best housing estate houses are those built in "garden cities."

In most cases such houses are in quite sound condition to start with. If they are allowed to deteriorate through neglect it is no use blaming the builder. Even if there are serious structural faults, it is better to tackle them than to do nothing but nurse a grievance.

After exterior paintwork, the maintenance of walls and roofing is the most important item. Most modern houses are pointed in cement mortar which does not readily decay, though it may drop out. Repoint any defective portions as soon as they appear.

Gaps between frames and walls may give trouble by admitting water. Remove any cover mouldings and point in bituminous mastic, as previously described. In poor quality speculative work flashings may be imperfect. Any gaps can be closed with mastic, though if the trouble is extensive it is advisable to get a plumber to fix new flashings.

Sills are often leaky in the cheapest speculative houses. They may lack a weather bar or a strip of lead which when bedded under the wood sill, the back being turned into the sill groove and the front turned over the brickwork, effectively keeps the weather out. Here again mastic is the easiest treatment, though if the brickwork is in poor condition you might cut it out under the wood sill and insert the lead strip to make it permanent.

Damp walls in modern houses

This problem has not yet been properly tackled, so that although it is possible to build damp-proof walls, you may find modern houses with damp walls.

If the walls are of solid 9-in. brickwork and the pointing is in good condition, with no defective flashings or open joints between frames and walls, then the rain is soaking through the solid brickwork. If the walls are of cavity construction (you can find this out by measuring the thickness, which for a cavity wall will be 11 in. or just over, plus the thickness of plaster and any rendering), then damp can only be admitted through defective construction. Common defects are described in Section II.

FIG. 4. REPAIRING CRACKED DOOR PANEL

With solid walls you may find that only one or two of the four outer walls are damp —the damp ones being exposed to the rain-bearing gales. The only treatment is some form of waterproofing, as described in Section II. A colourless waterproofing liquid is the cheapest and easiest to apply and has the advantage of leaving the appearance of the wall almost unaltered, beyond a slight darkening in tone.

Windows and doors

Wood swells slightly in damp weather and shrinks in dry. Swelling may cause casements to bind in the frames. If the windows are well made of well-seasoned material this trouble should not arise, provided the woodwork is kept well protected by good quality paint. The slightest flaking or crazing of paint will admit water to the wood, and, if the joints open a little, with shrinkage water will be admitted at a particularly vulnerable spot.

The trouble should be tackled in dry weather. Plane the edges of the casements where binding occurs so that they allow easy closing and opening. Then apply a coat of priming paint

immediately and follow up when dry with two coats of good paint. It is useless to plane edges and then leave the wood bare, as many people do. The wood must be protected or damp will enter, the wood will swell again and once more the casements will bind.

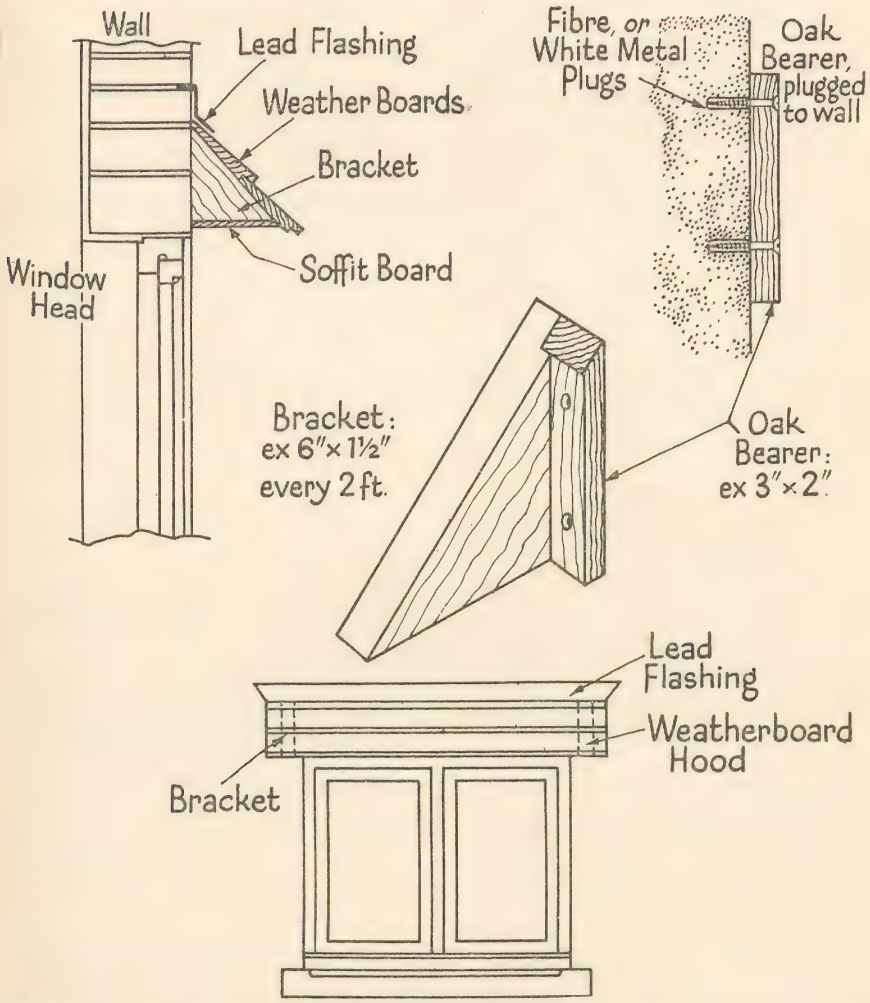


FIG. 5. ADDING A WEATHERBOARDED HOOD TO PROTECT A WINDOW FROM HEAVY RAIN

Oil hinges of doors and windows regularly. They need oil just as the moving parts of a cycle or car need it. Pin and strap hinges on gates and garage doors should be packed with grease. And oil the locks and bolts too.

If doors bind the trouble may be due to faulty hinges, or faulty hinge fixing. Or the frame may not be securely fixed.

If the bottom of the door touches the floor covering, take it off and saw a bit off the bottom edge, marking a line with a rule or marking gauge and using a saw with fairly fine teeth.

Steel windows may give trouble through rusting. Standard steel windows are now rustproofed as there has been so much

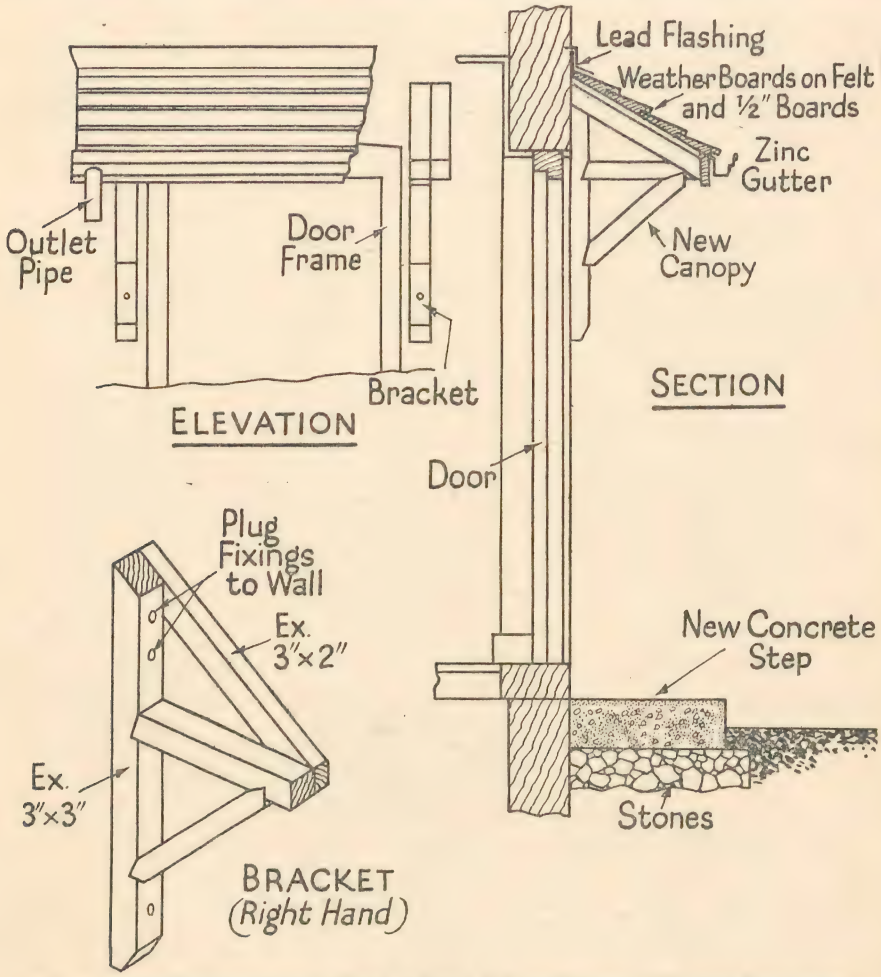


FIG. 6. WEATHERBOARDED HOOD ADDED TO DOORWAY TO GIVE WEATHER PROTECTION

trouble due to rusting. Of course, good paint protection would prevent this trouble, but it is useless to paint over the rust. You must not only remove loose rust with a wire brush, but get down to bright metal by rubbing with emery cloth. This may be tedious work but you will be rewarded by the cure of the trouble. Provided, of course, that you make a good job of the painting. Use a primer of the best quality specially prepared for steel.

Guard against dry rot

Most modern houses are adequately protected against dry rot, but there are exceptions. The ground floors are the most vulnerable. There has been a considerable increase in dry rot incidence since the war, due to bomb damage admitting damp and in some cases to houses being left empty for a time. The spores of dry rot become detached and are blown about so that they might get into a sound floor and under damp, ill-ventilated conditions infect the timber.

Keep air bricks clear, as already advised, and do not allow damp walls to remain untreated, especially if the dampness is near the timber floors. See to it that there are air bricks under the ground floors both front and back so that air can draw right through the floor and properly ventilate the timber. Some builders are careless in this respect, especially where a timber floor adjoins a solid concrete floor (see Chapter VIII; also Chapter VI, Fig. 2.

HOUSES IN EXPOSED POSITIONS

Houses in exposed positions should have very high resistance to rain-bearing gales and a high degree of thermal insulation. Construction which is quite satisfactory in a sheltered position might lead to dampness and cold, draughty rooms in an exposed seaside or moorland position.

Notice that old cottages and houses in exposed situations usually have thick walls, and are built in a long, low one-floor or bungalow form.

Damp-proof walls

Solid brickwork, masonry and concrete are porous, so if rain continues long enough water will pass right through the wall, especially if it is driven by strong winds. A strong wind will also drive rain and fine snow up the laps of slates and tiles and through small gaps in frames, etc. Increasing the thickness of a wall will delay the passage of damp through it but will not prevent it.

In Scotland, where exposed sites are common, the traditional form of damp-proofing a wall consists of battening out the interior plastering. Instead of applying the plaster direct to the

wall, the wall is battened on wood plugs fixed in bed joints. The plugs project about $\frac{1}{8}$ in. so that the vertical battens are just clear of the wall surface. Horizontal lathing is then nailed to the battens and the plaster applied to the lathing. Thus there is a clear space between the wall and the lath and plaster lining.

An improvement on this method has been suggested by the Building Research Station. Expanded metal could be used instead of wood lathing, and hessian could be stretched tightly over the vertical battens to avoid a thick undercoat and the possibility of the plaster filling the cavity. Wall plugs should be protected against rot with a colourless preservative, or could be of Western red cedar, which has high rot resistance.

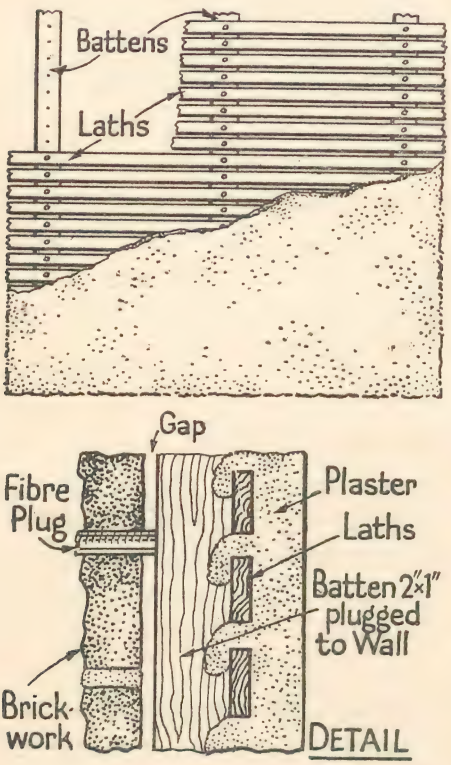


FIG. 7. SCOTTISH METHOD OF PLASTERING
Laths are nailed to battens, with clear space between battens and wall. This provides high damp resistance and improved thermal insulation

It is generally easier to treat the outside of an existing building rather than the inside of the walls. The treatments described in Section II are available. It might be mentioned here that roofs with a good projection at the eaves, and hoods or canopies over doors and windows, help to shelter the walls and reduce the amount of rainwater streaming down the wall face. Eaves can be extended provided the bedroom window heads are not too close, and it is easy to add a canopy to a door or a hood to a window, as in Fig. 6. In modern houses we are inclined to reduce or leave out these projections, and some modernist houses offend very badly in this respect.

Thermal insulation

The exposed house needs extra insulation if excessive heat losses in winter are to be avoided. The Scottish method of

battening out the plaster lining, just described, considerably increases the thermal insulation by providing an enclosed air-space as well as extra lining thickness.

The insulation of an existing house can be improved by lining with insulation board (at least $\frac{1}{2}$ in. thick) over the plaster. Battens should be plugged to the wall to support the edges of the board and one intermediate batten per sheet is also needed.

Heat losses through windows are considerable unless the windows are small. Much of these losses occur through air gaps around frames and doors. Gaps around frames should be pointed with mastic, as before described, and around doors they should be closed by fitting strip rubber draught-preventing material. In very cold positions double windows will be an advantage. It is quite easy to fit an extra fixed casement at the back of an existing fixed casement, while the opening casements can be left as they are.

Air brick vents built into the wall to ventilate the room admit too much air when strong winds are blowing. A constant flow ventilator is now on the market. This has movable vanes which automatically reduce the opening as the strength of wind increases. Existing plain vents can be treated by fixing a baffle board outside. This should be fixed to two battens, leaving a gap top and bottom.

THE MODERN HOUSE

Until recently all houses were built with what we call the staple building materials: brick, stone, timber framing with brick or plaster panels, timber joist floors with boarded floorings and lath and plaster ceilings, timber framed roofs with clay tiles, slates or thatch, the interior walls plastered and the exterior sometimes rendered and oil painted. That was about the sum of building materials, and they were all prepared and fixed by hand.

Today it is possible to build houses without using any of these materials, though the new materials have by no means displaced the old. In fact, for site built as against prefabricated houses, the traditional materials are still the chief materials used.

It is not so much the older materials as the older methods which are obsolete. Production methods are now vastly

different from the old hand-made methods. Bricks, with few exceptions, are machine-made, resulting in a bigger output, lower costs and scientific control of quality. Timber is scientifically seasoned, and is sawn, planed, moulded and jointed by machinery. Cements of the Portland and rapid-hardening types are, of course, modern and have largely displaced limes and Roman cements. But all materials, old and new, are now machine-made on mass production lines, and the same applies to equipment. It is quite true, of course, that with machine production we have lost the characteristic beauty and charm of hand craftsmanship. But we are finding a new beauty, as well as greatly improved utility, in the new machine craftsmanship. It is only when we use machinery to imitate hand craftsmanship that the result is absurd and ugly.

The new materials

Some of what I am including under this head have been on the market for many years, though new types and applications are constantly being made.

Many of the new materials are suitable for what is called "dry construction." Bricks, stone and plaster are "wet construction" materials, for obvious reasons. Now, the dry materials are better suited to the handiman because they only need cutting to size and can be fixed by simple means. You may not care to tackle plastering, but you could make quite a good job of fixing fibre board or asbestos-cement sheets.

Fibre boards

There are many types, and all are marketed under proprietary names. Ordinary wall board or fibre board consists of shredded wood fibre compressed to a low or medium density. They are made in various thicknesses from $\frac{5}{16}$ in. upwards. There are also cheaper paper pulp boards up to $\frac{1}{4}$ in. thick, but these are only suitable for temporary work as they are readily affected by moisture.

Fibre board of the ordinary type is suitable for interior use on walls, partitions and ceilings. If you want a high degree of sound or thermal insulation, use the thicker low-density board.

The thinner and more highly compressed boards are useless for this purpose.

The semi-hard boards are more highly compressed, less absorbent and not unlike whitewood in appearance. They are made in thicknesses of $\frac{1}{8}$ in. to $\frac{1}{2}$ in. They are stronger than the low-density boards. You can make single sheet partitions with them, framing the edges, and they may be used for the backs of cupboards and as light shelving.

Hardboards, or reconstructed woods, are very highly compressed and are made in thicknesses of $\frac{1}{8}$ in. to $\frac{3}{16}$ in. They are very strong and better than natural wood in many respects. They work easily with ordinary woodworking tools. As they are almost non-absorbent they can be used in exterior work if protected with oil paint. There are numerous uses for these hardboards, including furniture making and formwork for casting concrete with a smooth face (for the latter purpose they should be oiled to prevent adhesion).

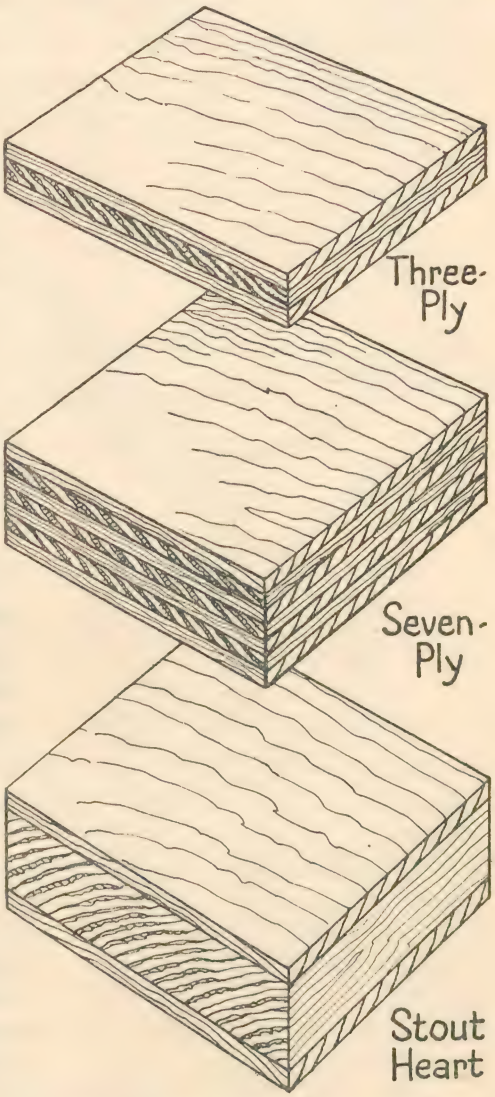


FIG. 8. THREE KINDS OF PLYWOOD

Ordinary fibre boards are rather absorbent and should not be used where there is a lot of moisture. They will burn and so should not be fixed close to fireplaces or stoves.

Some special fibre boards are treated to give high resistance to moisture, and others high resistance to fire.

Plywoods

This material is familiar enough, but there are several things you may not know. Plywoods are graded according to the knots and faults. You can get a grade with a lot of faults on one side and a few on another. Another grade has faults on one side but none on the other. And the best grade has no faults either side. Plywoods are obtainable with veneers on one or both sides, including birch, oak and mahogany.

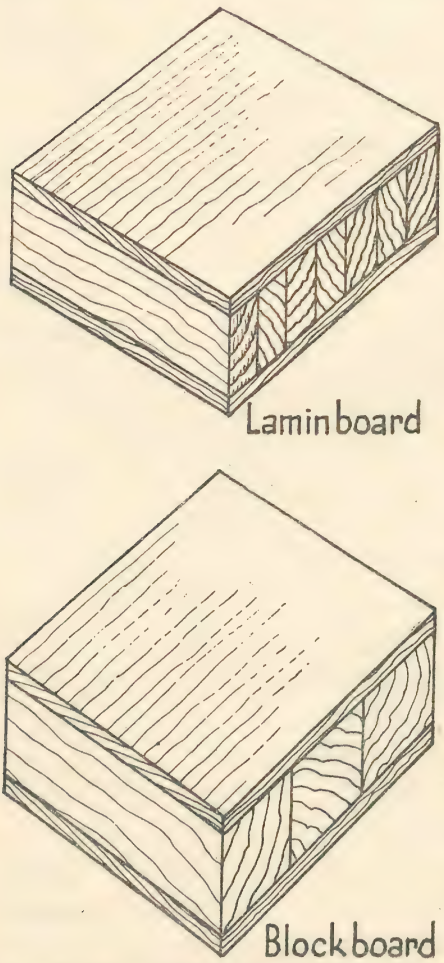


FIG. 9. THESE BOARDS ARE THICKER THAN ORDINARY PLYWOOD. THEY HAVE CORES OF THICK STRIPS OR BLOCKS

The handyman often buys material which is too thin for the job. Plywoods are made in thicknesses of from $\frac{1}{8}$ in. to $\frac{3}{4}$ in., the thinner sheets only are 3-ply, the thicker sheets 5- and even 7-ply. The maximum size usually in stock is 7 ft. by 5 ft. In selecting thickness, first decide the dimension between supports and then find which thickness will remain stiff over that dimension. By bending the sheets slightly you can soon find this.

Ordinary plywood cannot be used in a moist situation, as the glue would be dissolved by the moisture and the plies would separate. But there are resin-bonded plywoods, the adhesive being unaffected by moisture, and if these are oil painted they can be used in outside work. These plywoods are used in aircraft construction.

Laminated board and block board are thick plywoods with a thick core consisting of strips of wood, as shown in Fig. 9, with a layer or veneer of wood on each side. This material is rigid

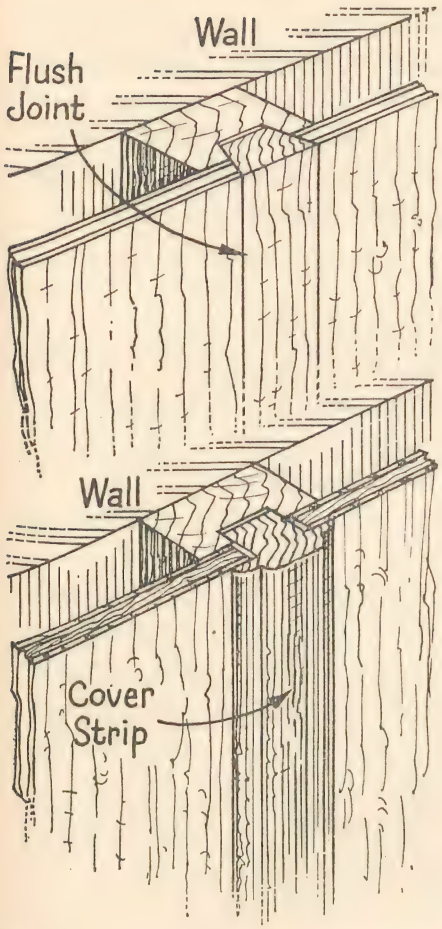


FIG. 10. METHODS OF FIXING PLYWOOD TO WALLS AT EDGES

in large sheets, and the thicker kinds are used for flush doors, with a suitable edging.

Metal-faced plywoods are obtainable with surface layers of galvanized steel, aluminium, stainless steel, monel metal, copper and bronze. The material can be sawn, and the edges can be sealed by cutting back one edge to allow the metal facing to be turned over and soldered to the metal on the reverse side.

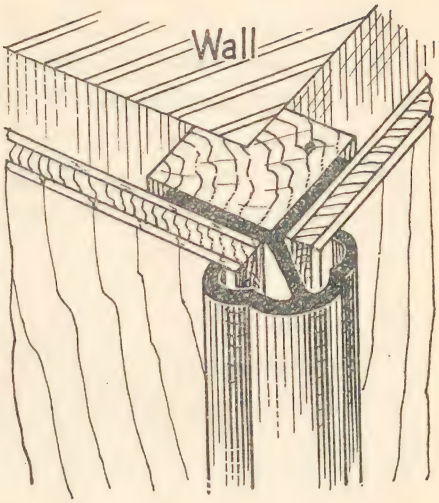


FIG. 11. METAL ANGLE COVER FOR CORNER OF PLYWOOD WALL LINING. SAME METHOD CAN BE APPLIED TO PLASTIC SHEETS, FIBRE BOARD, ASBESTOS-CEMENT SHEETS, ETC.

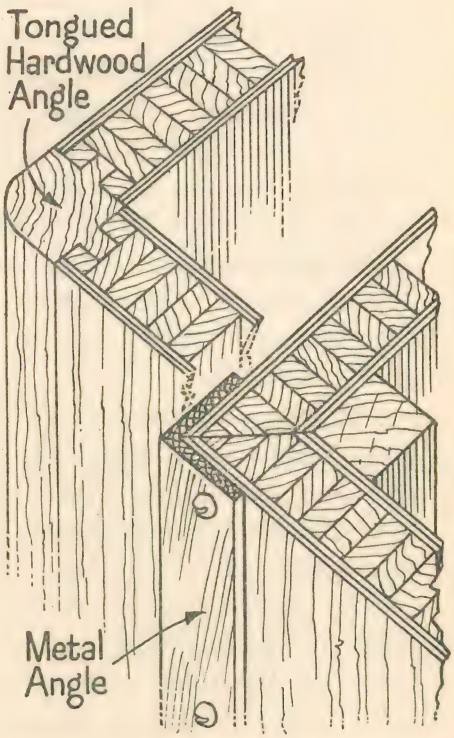


FIG. 12 TWO METHODS OF JOINING LAMINATED VENEERED BOARDS AT CORNERS

With sealed edges the sheets are watertight and can be used outside or for such work as shower bath cubicles. The material is very good for kitchen shelves and tables.

Plastic-faced plywoods are now made, with plastic sheet material cemented to the plywood. The hygienic and decorative plastic surface makes this material suitable for many uses in the house.

Plastics

Although many new uses have recently been found for plastics, they are not likely entirely to displace the staple building materials. In moulded form there is a severe size limitation, and with all but small simple shapes, the cost of making tools and moulds is very high and can only be warranted by mass production of huge quantities.

There are two main groups of plastics. The thermoplastic materials, which are softened by heating and then are moulded, will harden on cooling but will soften again on reheating. Articles made of thermoplastics must not, therefore, be exposed to heat. The second group consists of the thermosetting plastics which are powders. These are moulded into shape under the action of heat and pressure, which alter the properties of the material so that it hardens while hot. Once this has occurred the material is not affected by reheating.

Plastics are produced in three ways: in strip form by extrusion; in moulded form; and sheet form. A wide range of colours and decorative finishes is available, and also the transparent plastic which is used for motor-car windshields and aeroplane noses.

Hitherto the most familiar plastic articles have been electrical accessories, door furniture and wireless cabinets. Many others will soon become familiar, including sinks and draining boards, w.c. cisterns, shelving, table tops, sheet linings for walls and ceilings, lighting fittings and flush door veneers.

The plastic sheets consist of laminations of paper or cloth with a thermosetting resin. They are non-absorbent, heat-resisting, have fair thermal and sound insulating properties, cannot be attacked by insects or rot and do not require paint protection except when used outside. There is, however, slight expansion and contraction with temperature changes.

Metals

Metals are now widely used for windows, doors, door frames and linings, skirtings, picture rails, shelving, glazing bars, partitions, external cladding and internal lining.

Hitherto most metal-work for building has been of steel or iron protected against corrosion with oil paint. This has not proved satisfactory as slight defects appear sooner or later in the

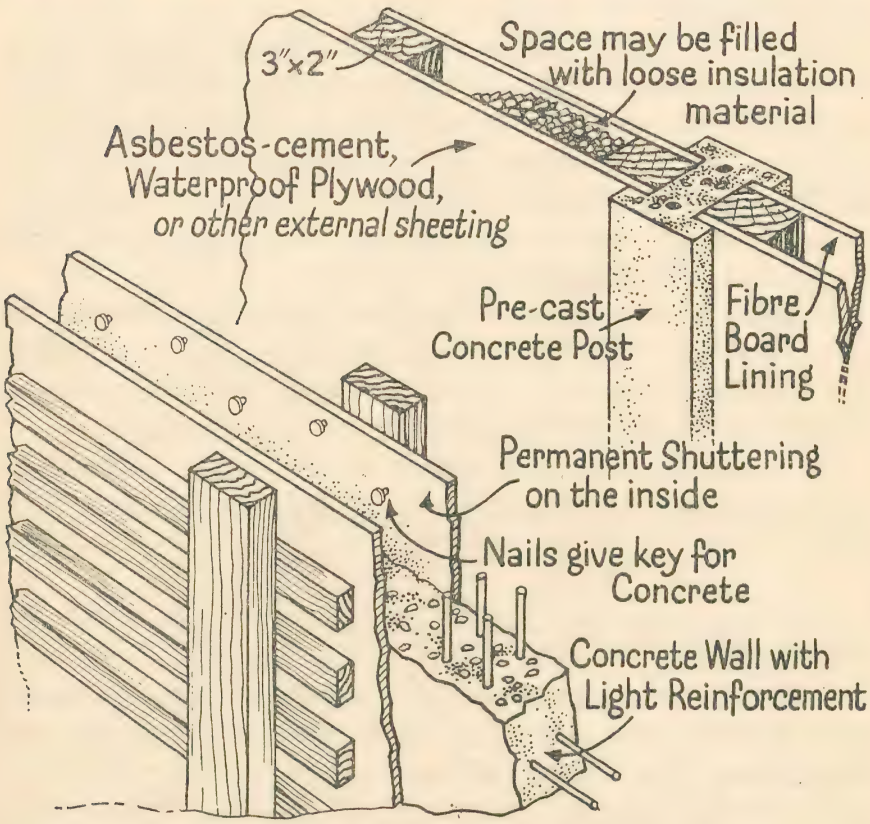

3"×2"
Space may be filled with loose insulation material
Asbestos-cement, Waterproof Plywood, or other external sheeting
Pre-cast Concrete Post
Fibre Board Lining
Permanent Shuttering on the inside
Nails give key for Concrete
Concrete Wall with Light Reinforcement

FIG. 13. TWO USES OF SHEET MATERIALS IN WALL CONSTRUCTION

Top: For wall cladding

Bottom: As permanent shuttering for concrete, the inside sheeting remains as ani nside wall lining

paint and corrosion then sets in. As it is very difficult entirely to remove rust, repainting does not always arrest corrosion.

The problem of corrosion has now been overcome. Rust-proofing processes such as galvanizing, sheradizing and parker-izing are now applied to standard steel windows and many other steel articles.

Aluminium alloys are now being used on a large scale for building equipment and structural purposes. They are light,

clean and do not readily corrode. They do not need paint protection, but can be decoratively finished by anodizing in various colours. As production of aluminium has increased sixfold in the past ten years, and the price is steadily falling, we can expect the use of this metal in building to be greatly extended.

Asbestos-cement

This material is familiar in the form of corrugated sheets. It is very durable and fireproof, and can be sawn and drilled with ordinary tools. There are now many applications of the material, including glazed and decorative sheets, rainwater gutters and down pipes, chimney pots of the anti-downdraught type, pipes for water mains and drains, flue pipes, draining boards and door canopies.

For interior work in kitchens, larders and bathrooms the glazed and decorated asbestos-cement sheets are very useful, and quite simple to fix. They can be used for lining walls and ceilings, making bath surrounds and for light shelving.

To make a separate w.c. cubicle in an existing bathroom, a glazed sheet can be framed in wood, taking up very little floor space.

Lightweight concrete

Ordinary mass concrete has disadvantages when used in house construction. It is dense and cold, and so encourages condensation. It is heavy and strong, but its strength is no advantage in the lightly loaded walls of a house. The stronger the concrete the greater the effects of shrinkage, so that there is trouble with crazing and cracking.

Lightweight concretes overcome most of these disadvantages, and the constituent materials are cheaper and easier to handle.

There are various methods of producing lightweight concretes. One of the easiest is by using lightweight aggregates. Natural pumice and furnace clinker and coke breeze are widely used, though some clinkers contain partially burnt coal which causes trouble by expansion.

Sawdust and shredded wood are also used with cement to make wood wool building slabs. This material has many uses

and is an excellent insulator, but it is quite different from lightweight concrete and not suitable for structural use.

Foamed slag is a processed lightweight aggregate which is now extensively used in block making. It is made from molten blast furnace slag and is more reliable than either ordinary clinker or coke breeze. Foamed slag concrete is in many respects as good as brickwork.

No-fines concrete is concrete with the fine aggregate (i.e. sand) omitted. It does not "sweat" and is excellent for house walls, though, like all lightweight concretes, it must be rendered with a water-resistant material as it is absorbent.

Cellular concrete, or aerated concrete, is made of sand and cement with the addition of a gassing or foaming material which produces numerous open cells.

Blocks made of lightweight concrete are very useful for alterations and extensions, though not all are suitable for outside walling.

PREFABRICATED HOUSES AND BUNGALOWS

It is necessary to distinguish between temporary and permanent prefabricated dwellings. The former are of light construction, and lengthy durability has not been considered in their design. The latter are claimed to have reasonably long life—in the region of 60 or 70 years. But as with the older types of construction, length of life depends largely upon maintenance.

The outstanding advantage of prefabrication is speed of erection on the site—a matter of a week or two, and in some cases a day or two. In fact, laying drains and other services may take longer than the actual erection of the house.

Transport is an important factor in prefabrication. This produces three main types: small sections which can be easily handled and transported on ordinary lorries; large sections which need cranes and special lorries; completely fabricated rooms or half or whole bungalows which are transported on special lorries and lowered on to prepared foundations.

History

A short note on the history of prefabs may reassure those who think that this type of construction will not last. A tollhouse with walls of cast iron flanged sections bolted together was erected near Birmingham in 1830, demounted in 1870 and re-erected as a canal lockhouse. This was still in good condition when finally dismantled in 1926. Then there is the case of the Crystal Palace—essentially a prefabricated structure—erected in 1851—and still in good condition when it was destroyed by fire a few years ago.

In various parts of Europe and America prefabricated timber houses have given satisfactory service for fifty years and more

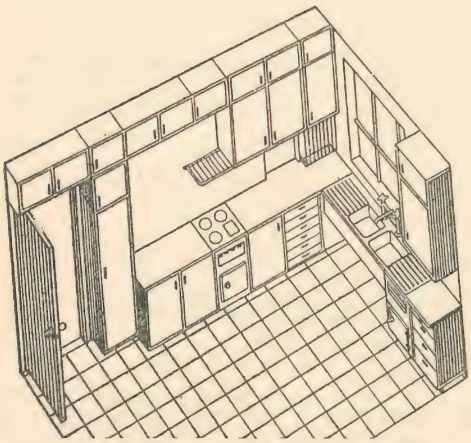


FIG. 14. KITCHEN FITTINGS STANDARDIZED BY THE ENGLISH JOINERY MANUFACTURERS ASSOCIATION

In Britain thousands of prefabricated steel, concrete and timber houses were erected between 1918 and 1939. A recent Government Report on the results of expert examination of these houses is, on the whole, very favourable. With only minor failures, most of them are still in excellent condition and the occupants are satisfied with them.

Principles

Standardization with mass-production is the first principle. The more thoroughly this principle is applied the cheaper the houses will be. At present there are too many types.

In a sense all houses are prefabricated to some extent. The principle of mass-production is applied to all building materials and equipment. We have standard ranges of windows and doors both in wood and steel, and this has resulted not only in lower costs but in better design. Recently a standard range of built-in cupboards has been adopted. Practically everything in modern house construction is covered by a British Standard Specification, to which most manufacturers adhere.

In prefabricated house construction a standard dimension

called the module is used, and the sections are manufactured in dimensions which equal the module or multiples of it. Thus with a 4-ft. module, sections for walls may be 4 ft. wide by 8 ft. high. It follows that windows should have a 4 ft. module so that they fit in with the sections. Unfortunately no common module has yet been standardized for all systems.

Planning must be done on the module system. A grid of squares is laid out on paper, the sides of the individual squares being the module dimension. Walls must be drawn on the grid lines, so that room dimensions are multiples of the module.

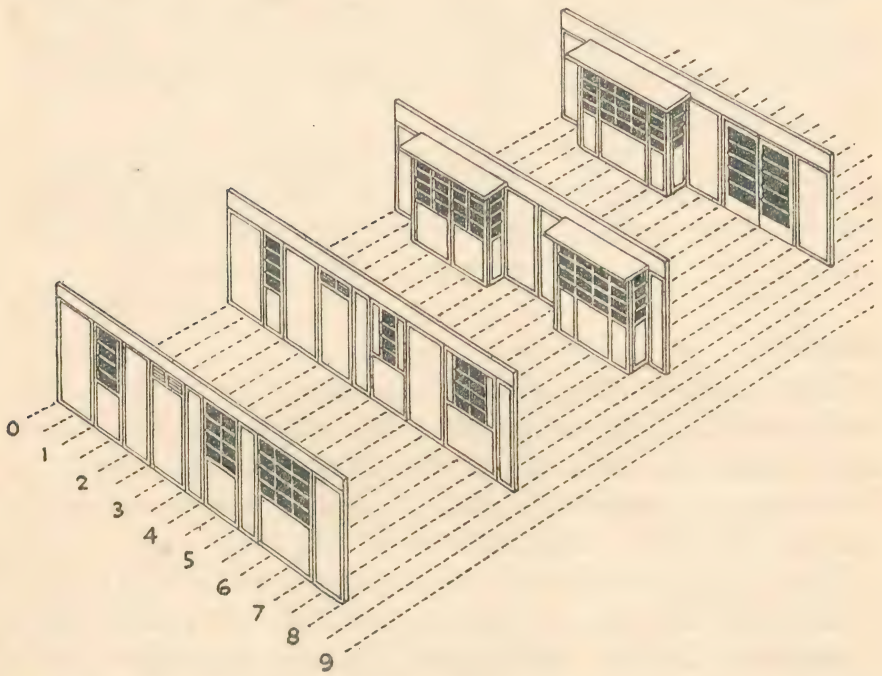


FIG. 15. HOW A VARIETY OF WALL AND WINDOW UNITS CAN BE COMBINED IN THE SECO SYSTEM OF PREFABRICATED CONSTRUCTION

Structurally there are two main types: (1) the framed type in which loads are taken by beams and piers or columns, which are filled in with panels. (2) The load-bearing section type in which loads are taken by wall and other sections just as they are in normal house wall construction.

Pre-cast concrete

This material is used in the production of both types. Pre-cast concrete structural units are reinforced with steel and are

cast in moulds. This is done in machines, the material being under pressure, and it is vibrated in the moulds to consolidate it and drive out air bubbles.

In the pier and panel systems, the piers are erected first and the roof principals can then be fixed. Wall panels and roofing can proceed at the same time. With this system the roofing can be completed before the interior finishing commences, so that the latter can be done under cover.

In the sectional system the walls are in heavy flanged units which are bolted together.

With both systems, an interior lining which will give both good insulation and a decorative finish is necessary. The finish is usually fibre board or plaster board fixed to clips or pads in the wall sections.

Pre-cast concrete has the advantage of being rot and corrosion proof, as well as fireproof. It does not need painting, though it may be colour washed, roughcast or treated with a cement paint, as the natural grey of the material is not a pleasant tone.

Timber

Light sectional garages and bungalows of timber have been made in Britain for many years. But although most of these are sectional and essentially prefabricated, they are deficient in insulation and durability. Prefabricated timber houses of the permanent type are much better in all respects.

Those with weatherboard cladding are framed. The interior is lined with fibre board or plaster board and the exterior has a double skin, the inner one being of plain boarding and the outer matchboarding. Bituminous paper or felt is interleaved between the two skins to make the cladding draught-proof. Floors and roofs are also made in sections.

In other systems there is a solid timber core faced with weatherboards, asbestos-cement sheets or resin-bonded plywood.

The systems in which plywood are used are very light and easily handled.

Care must be taken in all timber systems to keep the timber dry and so prevent rot. There is one timber—Columbian red cedar—which contains natural preservatives and does not need painting. Roof shingles are made of this wood and have a life of about fifty years.

Steel

Steel house systems are usually frame systems in which light cold-rolled steel sections are used, frames being welded at joints. For the outside covering asbestos-cement sheets, steel sheets and cement rendering on steel lathing are used, the interior being lined with any suitable building board.

For the prevention of corrosion, factory priming with red lead paint has been found satisfactory. For an external finish two coats of good oil paint can be added. Paint harling is a modern method of external treatment which not only protects the steel but gives a good decorative finish. This consists of a first coating of thick white lead, stand oil and gold size on which graded granite chippings are thrown, giving a roughcast finish. The chippings are coated with the paint mix before being thrown. Galvanizing is, of course, an excellent means of rustproofing, provided that holes are not drilled afterwards.

Aluminium

The properties of this material have already been described. An excellent bungalow has been produced by a section of the aircraft industry, using aluminium alloys and taking advantage of experience gained in large-scale aircraft construction. This bungalow, known as the "A.I.R.O.H." house (the letters standing for "Aircraft Industries Research Organization on Housing"), is made in four built-up sections, each 22 ft. 6 in. by 7 ft. 6 in., complete with wiring, plumbing and all equipment. The weight of the complete house is less than 10 tons and the four sections can be transported on four 5-ton lorries. A great advantage of this house is that no elaborate foundation is required. The house stands on built-in screw jacks for which concrete paving slabs provide sufficient foundation, the jacks being adjusted to suit the site levels. This description applies to the prototype bungalow, but the same system is said to be quite suitable for two-storey houses.

Jointing

To make weathertight joints which will remain weathertight is one of the most awkward problems of the prefabricated system of construction. With small units such as bricks, shrinkage and

thermal movements are evenly distributed through the numerous joints and are very rarely sufficient to cause cracks. With the large sections which we have in prefabricated systems, these movements set up stresses in the joints which may crack them unless the joints are flexible or ductile and accommodate themselves to the movements.

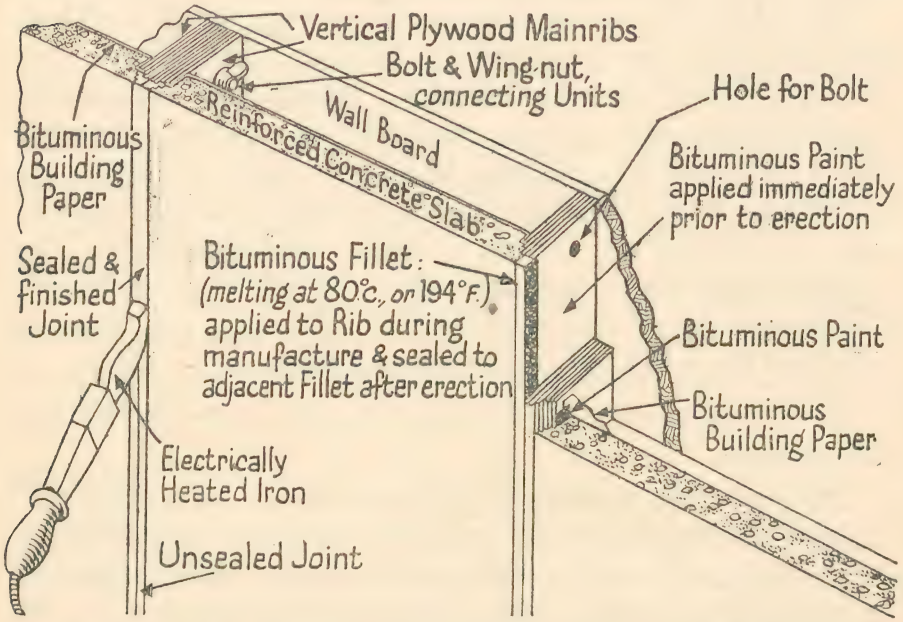

Vertical Plywood Mainribs
Bolt & Wing-nut, connecting Units
Hole for Bolt
Wall Board
Reinforced Concrete Slab
Bituminous Building Paper
Bituminous Paint applied immediately prior to erection
Sealed & finished Joint
Bituminous Fillet: (melting at 80°C., or 194°F.) applied to Rib during manufacture & sealed to adjacent Fillet after erection
Bituminous Paint
Bituminous Building Paper
Electrically Heated Iron
Unsealed Joint

FIG. 16. METHOD OF MAKING SEALED WATERTIGHT JOINT IN ONE OF THE TARRAN SYSTEMS OF PREFABRICATED WALL CONSTRUCTION

There are several proprietary jointing materials which retain flexibility over a long period. Most of these are bituminous mastics. The joint is so designed as to form a key which securely holds the mastic filling. In most systems the joints are filled with a mastic gun—an implement which forces the jointing material into the joint space. It can also be used for the easy repair of defective joints.

CHAPTER IV

BUYING A HOUSE

There are many factors to consider in buying a house which do not enter into the purchase of anything else. In buying a car, for example, you have merely to decide your maximum price and then pick the best car at that price. But in buying a house it is not so simple. You have to consider position and environment, transport and communal services, the garden, the subsoil, the cost of maintenance and upkeep and the structural and decorative condition. These factors are quite apart from the question of whether the house itself appeals to you or not.

First, you must decide what you want most, and then arrange the other factors in order of importance. You may decide that a compact plan and first-class modern equipment are essential, while the position or the size of the garden does not matter much. Or you may be a keen gardener and countryman and decide that it is worth while travelling fifteen or twenty miles to and from your work in order to have plenty of ground in rural surroundings. It is up to you, but take care to get your scale of values right. There are people who buy a house for some quite irrelevant fancy and discover after they have moved in that it satisfies none of their real requirements.

Another important point is to follow your own scale of values and not someone else's. This is all the more important if you have some unusual or unconventional taste or requirement. Then your friends will try to put you off it. Remember, you have to pay for the house and live in it.

Position and environment

The first thing to decide is where you want to live, but unless you know the whole district very well, do not decide before you have thoroughly explored it. Obviously the wider the area in which you are prepared to buy a house the wider the choice.

In many cases transport services to and from the place of work

is a limiting factor. But, assuming that you work in a large town, it is not so much distance as the time-table that counts. If there is a good service of fast trains or buses which will take you almost from door to door, a distance of ten miles is nothing much. But with a poor transport service or a considerable distance to walk to bus or train, even three miles may matter a lot. Get a large scale map of the district and select your potential areas along the main public transport routes. Then

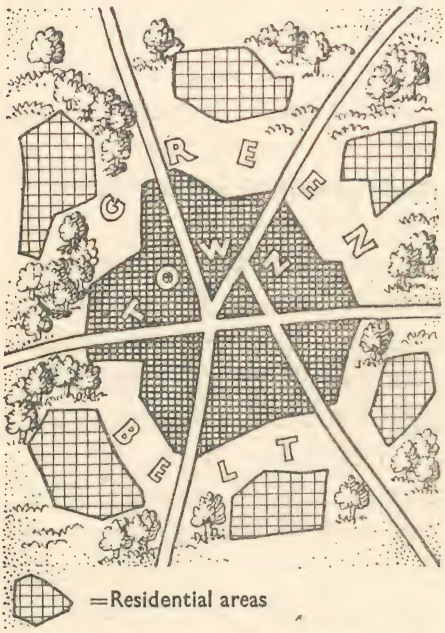


FIG. 1. IN MODERN TOWN PLANNING THE SUBURBAN RESIDENTIAL AREAS ARE SEPARATED FROM THE TOWN BY A GREEN BELT; AND LIE BETWEEN, NOT ON, THE ARTERIAL ROADS

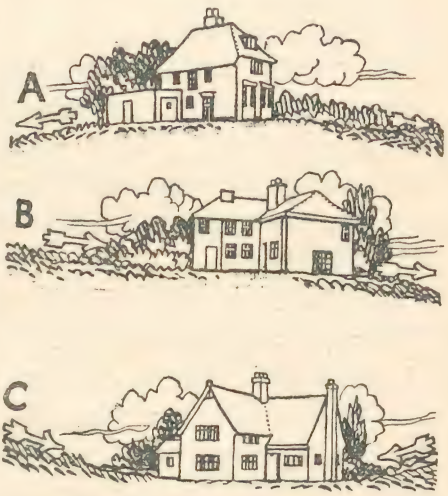


FIG. 2. NATURAL DRAINAGE

A. The top of a hill is best as surface water drains away from house

B. A sloping site is good provided water is not allowed to collect against house

C. A basin site is bad unless artificially drained

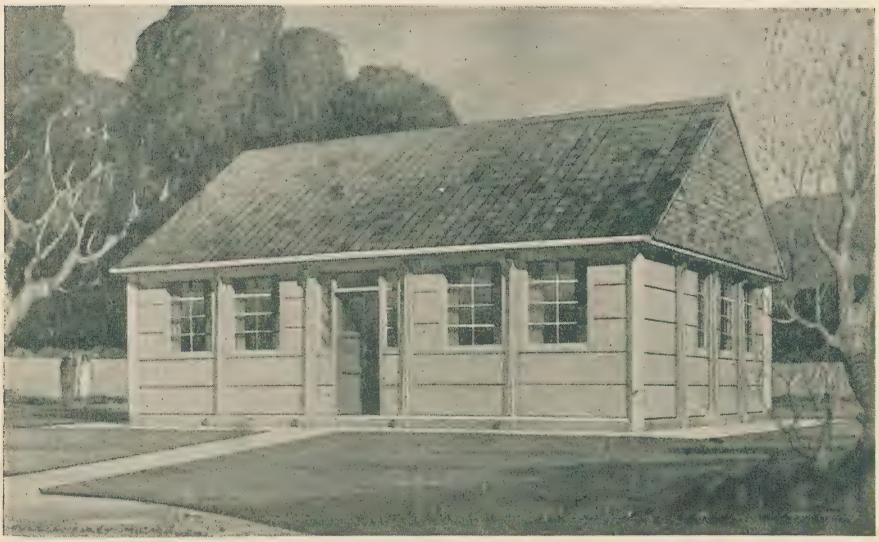
go and walk round any with which you are not already familiar. You will probably find at least half a dozen separate areas in which you would be prepared to live.

Then there are the local amenities. The shops, schools, cinemas, welfare centres, doctors, parks and recreation places. Look into these and decide if they suit you. If you have young children you will not want a house on an arterial road or in a spot which involves crossing dangerous roads to get to the nearest school.

The immediate environment must be considered in relation not only to transport and other communal services, but to the

The "Orlit" prefabricated house of pre-cast concrete units with a flat roof. See p. 43.

B



The B.C.C.F. bungalow. Another prefabricated dwelling of pre-cast concrete units. See p. 43.

(Photos: Cement and Concrete Association)

A

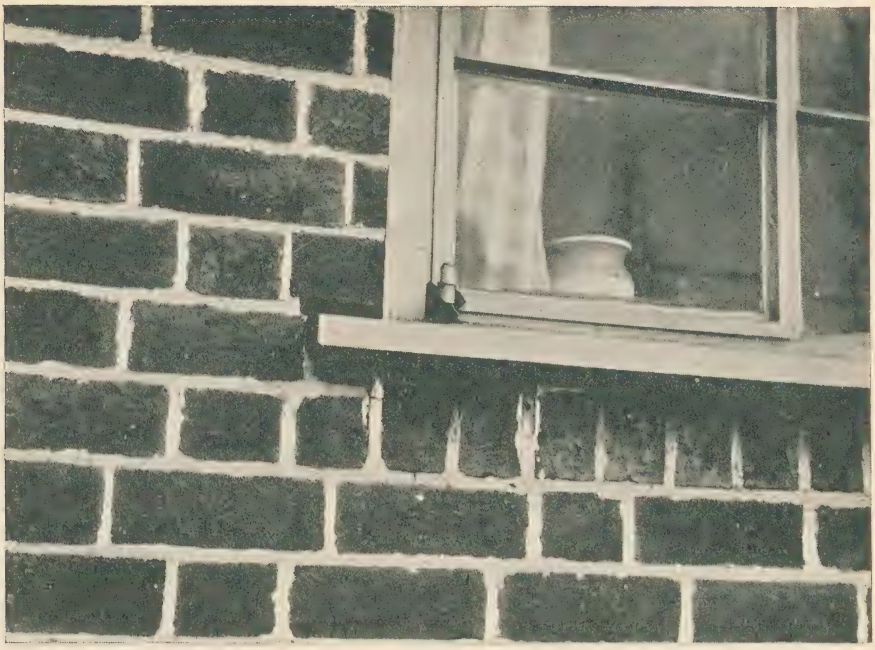
Timber-framed cottage ruined by neglect. Upper panels in the gable end are brick filled. Lower panels have old wattle and daub filling. The upright sticks are tenoned into the beams and wattle is woven between sticks. See p. 2.

B

Half-timbered house, Worcestershire. Angle-braced frame. These larger houses are spacious with good headroom. They are not difficult to keep in good condition. See p. 2.

(Photos: Edgar Lucas.)

A



Brickwork with thick joints, cream tinted pointing. Notice where pointing has dropped out around sill. Such a defect should be put right without delay. See p. 102.

B

In brickwork look for defects such as this—defective pointing in a straight joint. See p. 102.

C

Toothing left so that another wall can be bonded to that shown, thus avoiding a straight joint. On the left facing bricks; right common bricks.

(Photos: Edgar Lucas.)

PLATE IV

A

Window in stone wall. Notice decay which could have been arrested by preservative treatment. See p. 108.

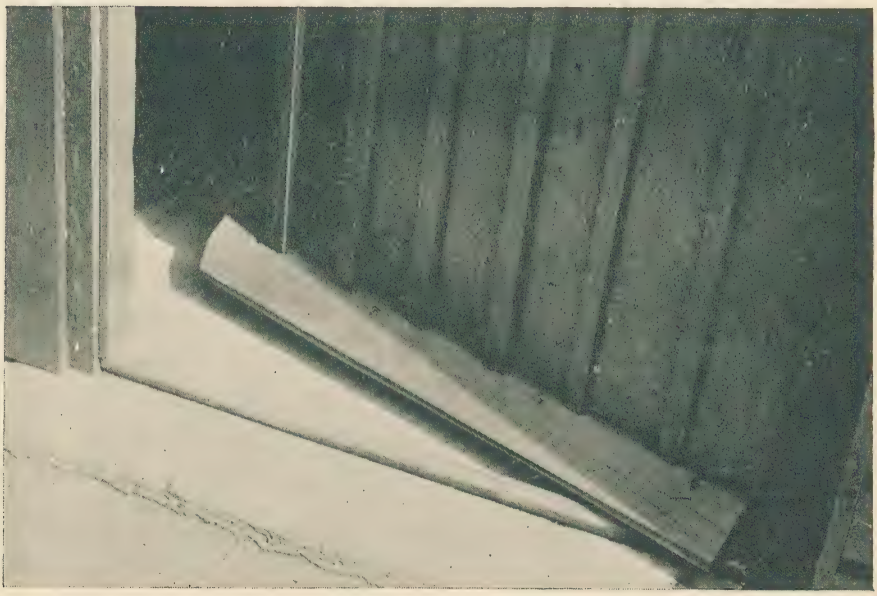
(Photo: Edgar Lucas.)

B

Modern flush door in oak veneer. See p. 171.

(Photo: Samuel Elliot and Sons, Ltd.)

C

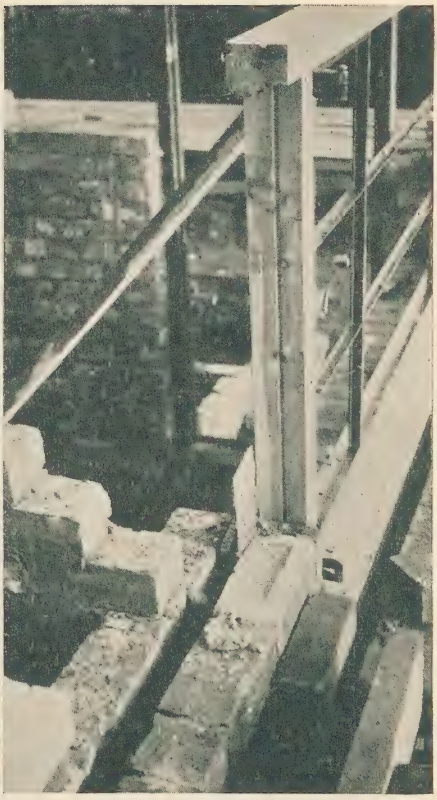


Weatherboard and threshold to prevent rain driving under door. See p. 175.

(Photo: Edgar Lucas.)

Example of modern brickwork. Phorpres bricks colourwashed.

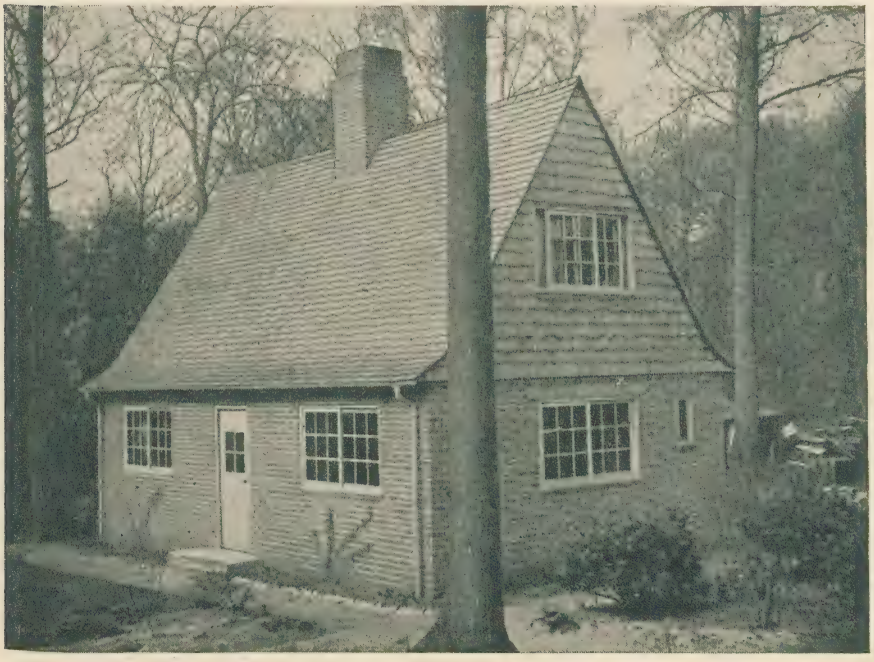
(Architects: Messrs. Joseph with D. G. Armstrong, F.R.I.B.A.)



Detail showing window being built into a cavity wall. See p. 12.

(Photo: Edgar Lucas.

C



Modern cottage. Brick walls. Roof and gable ends covered with cedar shingles. Sliding windows.

(Architect: Oliver Hill, F.R.I.B.A.)

A

Sixteenth-century half-timbered house. Notice the fine oriel window and doorway. See p. 2.

B

Georgian cottages with rendered brick walls (lime and sand stucco). This must be well protected by frequent oil painting. See p. 7.

(Photos: Edgar Lucas)

A

Brick cottage. Plain but sensible design. Well preserved. See p. 6.

B

Cotswold cottage. Rubble walls and stone slab roofing. With careful maintenance such a cottage can be kept in good condition. See p. 107.

(*Photos: Edgar Lucas.*)

A

Typical Victorian house. By painting the woodwork white the heavy appearance is greatly relieved. See p. 17.

B

A well restored half-timbered house. New leaded-light windows in oak frames have been fixed and the wall panels and roofing repaired. See p. 2.

(Photos: Edgar Lucas.)

nature of the road and adjoining property, traffic and other external noises, sunlight and aspect of the main rooms and the view from the principal rooms.

If you have a car the transport problem is considerably simplified, though remember that the family will still largely depend on public transport.

In a partially developed area, the possibilities of future development should be examined. If you buy a house and someone builds a fried fish shop next door it will not improve the value of your property. You can find out from the local surveyor if there is a town or country planning scheme covering the district, and if so what restrictions apply to the development of the area in view. These schemes are designed to protect the amenities, and certain areas are scheduled as residential, though sites within a residential area may be reserved for shops and other special buildings.

If the area is only partially developed you may be attracted by the semi-rural surroundings or an open view. But if development is likely to continue these pleasant amenities are not likely to last long. If you want to be sure of a permanently open outlook near a town you must buy a house overlooking a park, recreation ground or golf course.

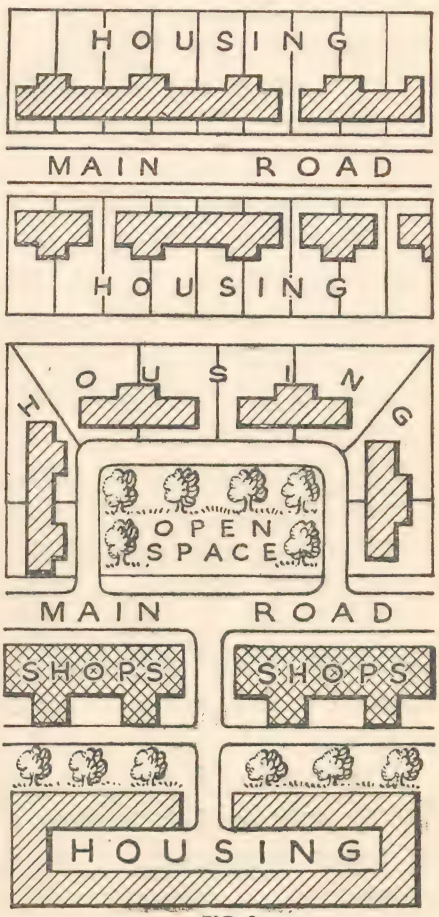


FIG. 3

Top: **Ribbon development. Houses on main roads mean road dangers**

Bottom: **Houses are better situated in side roads, cul-de-sacs or short service roads**

Main services

The services laid on from public mains (electricity, water, gas and sewerage) are taken for granted in towns, but on the fringe of the town there may be one or more absent.

In the country there may be no main services, though electricity is now being rapidly extended in country districts. Main water is available in and near most country towns and some of the larger villages.

Now let us see just what disadvantages are involved in the absence of main services. It is true that they can all be overcome if you can afford to put in rather costly plant. Small, automatic generating sets are made driven by petrol and oil engines (and even windmills). With electricity you can instal an automatic pump to draw water from a well to a storage tank in the house. If the water is not pure you can fit sterilizing equipment.

A cheaper way of providing lighting and cooking heat than installing electric plant is to buy gas compressed in cylinders (Calor gas and Bottegas). This can be used in ordinary gas fittings for lighting, cooking, ironing and heating.

In the absence of a public sewer the only really satisfactory method of sewage disposal is to instal a septic tank with an ordinary drainage system. The septic tank leaves an effluent which, though not quite pure, is harmless if discharged into a stream or ditch. But it is important to have the septic tank properly designed and built. The work should be entrusted to one of the specialist firms who make the necessary fittings.

The chemical closet is a cheaper alternative. With an absorbent subsoil a special type of chemical closet with provision for drainage into an underground soak-away can be installed.

A cesspool with an ordinary drainage system is not unsatisfactory provided that the local authority undertake the emptying by means of a special emptying vehicle fitted with a suction pump.

With both the septic tank and cesspool systems an adequate water supply is required for flushing w.c.'s.

Thus the absence of main services can be overcome, but even the best equipment requires some maintenance and is costly to instal. Running costs are greater than with main services.

Structural and decorative condition

The structural condition is more important than the decorative. In both conditions vary a lot, and the age of the house

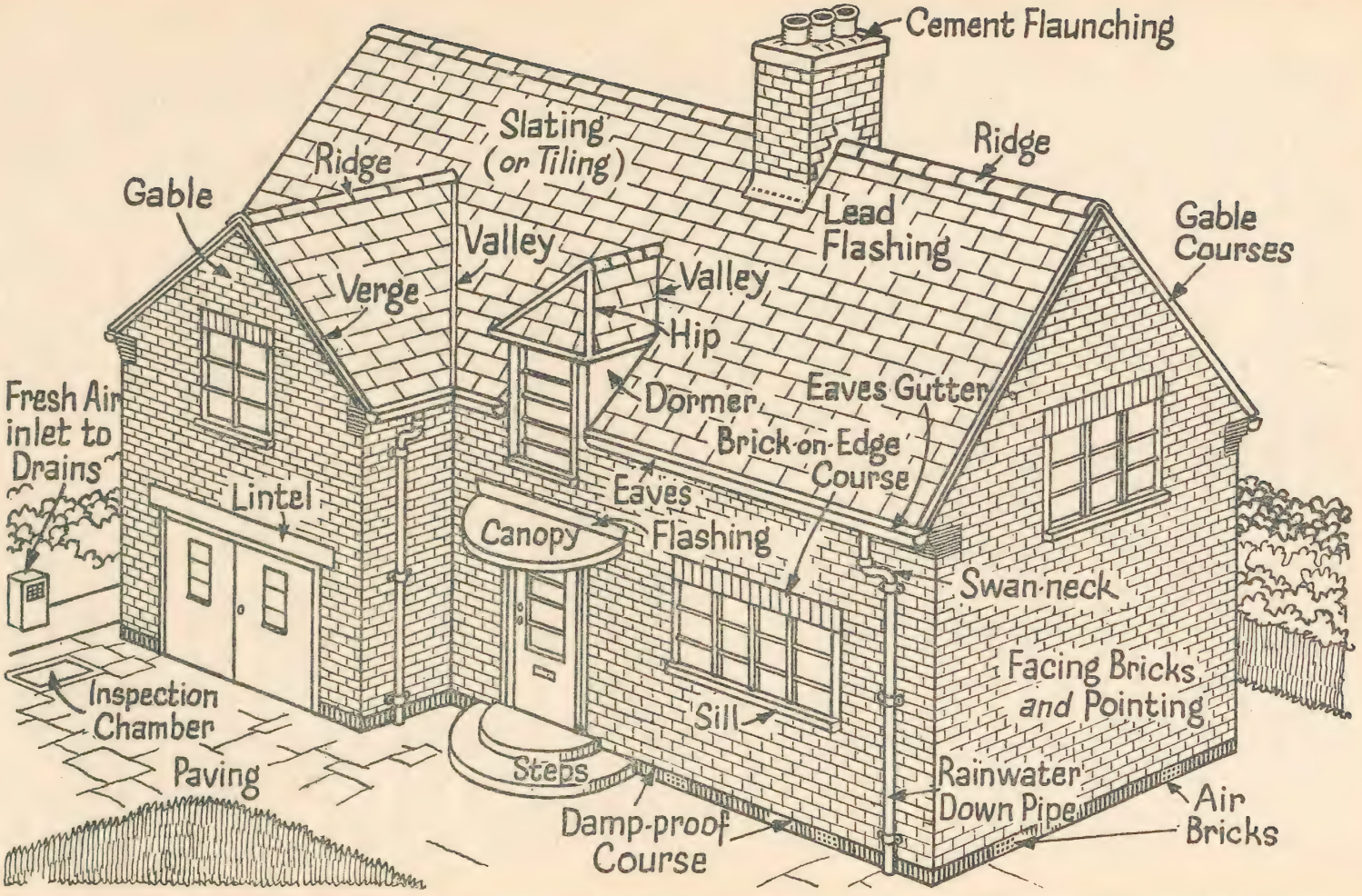


FIG. 4. NAMES OF THE STRUCTURAL PARTS MENTIONED IN THIS CHAPTER, AND SOME OF THE POINTS WHICH SHOULD BE EXAMINED

has little to do with the condition. A house two hundred years old may have been restored and well maintained, and be in much better condition than another ten years old which was not well built and has since been neglected.

The surface condition of walls, ceilings, floors, etc., may be deceptive. Make a systematic survey. Go over the outside first. Take a notebook and enter the condition of every part. Examine the walling and note the condition of the jointing, the bricks, stones, timber or rendering, the windows and doors, including heads and sills. Then examine the roofing—from a ladder if possible. Note any displaced tiles or slates and any unevenness. Carefully examine the flashings round chimneys and parapets. Examine the chimney jointing and the top of the chimney to see if the cement flaunching and pots are in good condition. Finally, look for the damp-proof course, which is generally revealed by an extra thick bed joint about 6 in. above ground level.

Now go over the walls inside the house, taking the outer walls first. Look for signs of damp—generally revealed by discoloured patches. Examine the plaster, and if the wall is papered tap it with the knuckles. Any loose patches will be detected by the characteristic "hollow" sound. Examine the ceilings. If there are cracks, distinguish between fine crazing, which is no great matter, and deep cracks, which are more serious.

Next take the woodwork: windows, doors, door frames and linings, skirtings, shelves and staircase. Note any signs of rot. Test the woodwork for secure fixing. Take hold of it and pull or push it, and note any looseness. Open and close all windows and doors to test the fitting. Look for signs of weather penetration around windows and doors—indicated by discoloured patches. It is better to examine the house during or just after a prolonged downfall of rain for signs of damp—not only through windows and doors but through walls and roofs.

Examine all hinges, locks and door and window fittings, and note any defects. In many cases there are quite a lot, and to repair them adds to the cost.

The staircase and landing may contain many defects—especially in a cheaply built house. Try the treads for squeaks and other signs of looseness. Take hold of the handrail and

try the strength of the balustrade. Test the newel posts in a similar way. On the landings look for signs of settlement around the staircase well. If the staircase is in good condition everything will be rigid, level and square.

Above the top landing there is usually a trap door into the roof space. Get a pair of steps and examine the roof from the inside. It is not necessary to climb inside—just stick your head and shoulders through the trap. If you can see daylight through the roof do not be unduly alarmed. Some daylight will penetrate the laps of tiles and slates. But in the case of tiles it is a sign that there is no mortar torching and no underfelting. If the house is in a high exposed position there is the possibility that rain and snow will blow into the roof. The condition of the roof timbers should be noted. In a very old roof there may be rot and the joints may be giving way.

The floorings should be carefully examined—especially the ground wood floors, as these are more likely to be attacked by dry rot than the upper floors. Look for the air bricks front and back in the outside walls, as lack of ventilation usually leads to dry rot. Test the floorboards by stamping on them at intervals. If possible obtain permission to prise away a skirting board in each room. Dry rot in a floor spreads rapidly to the skirting backs.

Examine the solid floorings—quarries, tiles, terrazo, etc. Note any badly worn or rough areas and any cracks or loose tiles.

As you examine each part of the house, glance along the walls to see if they are plumb. Test flat surfaces (floors, window boards, sills, steps, etc.) with a small spirit level. Look for signs of unequal settlement, which consist of cracks in walls running from top to bottom, leaning walls and sloping floors. In a very old house do not be alarmed by signs of settlement, provided that it has not seriously strained the structure and that the movement is not continuing.

Equipment

Equipment and fittings are very important. If possible test every piece of equipment under working conditions. Notice if there is any down-draught when the fires are burning and if the range oven is properly hot. Test the hot water supply at

each tap. Examine the sanitary fittings for cracks and chips and test all taps and waste pipes for leaks.

If the house is in an exposed position, notice if the water pipes on outside walls are protected against frost. If there are tanks in the roof, notice if these are lagged against frost.

The type of equipment is just as important as its condition. If it is old and inefficient by modern standards, you may have to consider installing up-to-date fittings, which will add considerably to the cost of the house.

If it is a big house and has no central heating plant, it may be that the existing heating arrangements are inadequate, and you will have to consider whether to instal extra electric or gas heaters, or central heating plant.

The electric lighting and power and the gas installations should be examined, testing the fittings and also noting the number of lighting and power points and their positions. In many cases power points are inadequate, and a note should be made of the number of new points required. If gas only is laid on, the absence of electricity is not such a disadvantage as might first be thought. Recently-introduced gas equipment is much better than the old types. A bayonet type "plug-in" fitting is made which enables portable apparatus—gas fires, irons, etc.—to be easily connected and disconnected. The only great disadvantage in having gas instead of electricity is that wireless sets must be run from batteries. It is, of course, quite possible that though the house has no electric installation the mains are not far away and that it could be wired and connected at moderate cost.

The drains being concealed cannot be closely inspected, but look for the inspection chambers (there should be at least one and preferably two). There should also be a fresh air inlet near the front boundary fence, and a vent pipe against the house. If in a suburban or rural district, the drains may not be connected to a public sewer, and the method of sewage disposal should then be investigated.

Fencing

If the property is bounded by timber fencing the posts should be carefully examined where they enter the ground. Rot readily occurs for a distance of about 12 in. below and above

ground level. But, of course, the whole fencing should be scrutinized. Timber fencing, unless of oak, soon decays, and examination may show that the whole fencing requires renewal.

Brick boundary walls should also be examined. The pointing and the coping are the two items which most readily decay. If the walls lean or there are extensive cracks an inadequate foundation is indicated—a common fault.

Gates should be examined—especially the joints where rot usually commences.

Decorations

Do not be discouraged if the interior decorations are in poor condition. Though this will make the interior look unattractive, it can be put right at a moderate cost, and you can choose your own decorative scheme. Moreover, the recently redecorated interior may conceal defects beneath its superficial smartness. Newly-papered walls and ceilings may have soft or cracked plaster underneath. Papered ceilings should be suspected, because paper is often applied to support loose plaster. The new wall decorations may also conceal patches of damp if the weather has been dry since the decorations were applied.

Distemper cannot conceal defects very easily. It may conceal damp patches to any but a close inspection, but if you look carefully you will find any damp patches showing through new distemper as slightly darker tone areas. Even fine cracks in the plaster are revealed to close inspection.

Exterior painting is important, not only from the decorative standpoint, but even more as a protective coating. Defective exterior painting lets in damp which will soon set up rot in woodwork and rust in ironwork. But discoloured or shabby paintwork may still provide a protective coat, provided that it has not cracked or flaked. Of course, here and there you will find small defects in old paintwork, but if they are very small and few you may take it that the paintwork was well done. If the exterior woodwork has just been repainted it will make the house look attractive, but it may conceal defects. Even rotten wood and rusty metal can be concealed beneath a new coat of paint.

Defects under new paint may be detected by slight roughness or unevenness. If the paintwork has a good smooth surface it

indicates at least that it has been well done and that the material surface underneath is reasonably sound.

In exterior woodwork rot is liable to attack sills and the feet of door and porch posts. If you stick the point of a penknife through the paint you can see the bare wood and any rot will be revealed. In an old house there will certainly be some decay at these points, but it will be wet rot, not so dangerous as the dry rot which may attack floors and unventilated timber.

If new paintwork is of poor quality it will not last long. The surface should be smooth and regular. Poor paintwork is indicated by blisters, fine cracks or crazing, bleeding and chalking.

Cost of upkeep

This matter should be looked into, especially if the house you propose to buy is of a different type or larger than houses you have hitherto lived in. There are the fixed charges—rates and water rate, and ground rent if the property is leasehold—but these are dealt with later in the section on Law and the Householder.

The following are the principal items:

Repairs. Once a house has been put into good condition it should not be costly to keep so, though much depends on the quality of the original materials and workmanship. And even more depends upon attending to every little defect as soon as it appears. The stitch in time costs very little. If you are a handyman and can make a fairly neat job of a simple nature in woodwork and wall pointing, maintenance repairs on a small three-bedroom house may not cost you more than £1 a year. The only jobs you will have to get a building repairer to do are those out of reach—such as chimney tops—and those which need considerable skill such as plumbing jobs. But if the house is well built such jobs will not crop up more than once in ten years.

Even if you do not do any work yourself beyond the trifling jobs, such as fitting a new tap washer, £5 a year should cover the maintenance repairs of the soundly built small house.

Painting and decorating. The cost of this item depends on two factors—the amount of surface to be covered and the frequency of repainting and redecorating. The exterior of a small

house can be repainted by a professional painter for about £10 (taking the cost as 50 per cent. above 1939 prices). That includes rubbing down but not burning off. If the old paintwork is in bad condition and has to be burnt off or stripped with a chemical stripper, it will need a priming coat and at least two coats of paint, and will cost much more than £10.

This brings us to the question of frequency of repainting. Exterior work should be rubbed down and receive one coat of best paint every three years if you wish to keep the work in good and clean condition. Every twelve months you should wash the exterior paintwork down with warm water. This will freshen it up and help to preserve it.

Interior paintwork should be rubbed down and receive a coat of good paint every five years. As to the walls and ceilings, much depends on how the house is used. Children knock the wall decorations about, and a smoky atmosphere soon darkens light-toned decorations. In the average case redecoration every three years will keep the interior fresh and smart, and with careful use and by removing finger marks at frequent intervals, every five or seven years is enough.

Domestic assistance. The average small house is run by the housewife, in some cases with the help of a charwoman. This expense is a matter for the individual. But it is worth pointing out that with modern labour-saving equipment it is easier for the housewife to run the home unassisted than it is to run a poorly equipped home with a charwoman or servant. For easy working you need not only good equipment but a compact house with plenty of space in the rooms so that you can move around easily. Small, overcrowded rooms are not easy to keep clean.

Gardening. This, too, is a matter for the individual. If you do your own gardening the cost is not great, unless you go in for expensive bedding layouts and run a hot-house to provide exotic plants. With a garden over a quarter of an acre you will need some assistance, and the large mansion garden costs a lot of money, of course, both in plants and labour.

It is possible to work a large garden cheaply and without much hard work if you have simple herbaceous borders—not too extensive—and shrubberies, with a large lawn, which can be easily managed with a power-driven mower.

Growing vegetables to provide the family all the year round is rather hard work. But even if you pay to have this done you save money in producing your own food.

Paths and drives need a certain amount of maintenance, unless they are of concrete. Red furnace ashes, often used for cheapness, are not advisable, as they "pick up" in wet weather and frost can make quite a mess of the surface. Gravel is good if frequently rolled. Stone or concrete slabs are best, as they look well, are durable and the only work needed is keeping the open joints free of weeds—which can be done by treating with weedkiller occasionally. Frequent use of weedkiller is essential on gravel and ash paths—unless you are one of the very few who enjoy weeding.

CHAPTER V

THE LAW AND THE HOUSEOWNER

Buying and selling a house

Owing to its very nature and to the complicated dealings which have been carried out in connection with the ownership of land over the centuries, it is not possible to carry out the sale and purchase of land in the same manner as it is a piece of furniture.

In a work of this kind it is impossible to deal fully with all questions which arise in conveyancing, but only to give a general outline of the most salient points.

The common practice of persons who wish to buy or sell property is to take the advantage of the services of an estate agent. A proposed vendor (seller) may employ an agent as sole-agent or, on the other hand, may decide to place the property in the hands of several agents.

In the event of the agent being appointed sole-agent, he will be entitled to his commission even if the property is sold through some other agency.

A number of cases have been decided as to whether an agent is entitled to this commission if, having been instructed to sell property, he finds an able and willing purchaser only to find that the owner refuses to sell to that person.

Care should be taken when employing an agent to see that he will only be entitled to his commission in the event of the purchase being completed, as in some cases it has been decided that the agent has been entitled to his commission, or damages which equal the commission, although the sale has not been completed because the proposed vendor has changed his mind.

When the negotiations have been completed either through an agent or privately, a contract in writing must be entered into. It is provided by section 40 of the Law of Property Act, 1925, that "No action may be brought upon any contract for the sale or other disposition of land or any interest in land, unless the

agreement upon which such action is brought, or some memorandum or note thereof, is in writing, and signed by the party to be charged or by some other person thereunto by him lawfully authorized." The agreement or memorandum in order to comply with this section must (i) show the names or descriptions of the vendor and purchaser, (ii) sufficiently identify the subject-matter of the sale, (iii) show the price or consideration, (iv) include any special terms upon which the property is sold, and (v) must be signed by the person to be charged or his agent.

The memorandum may consist of more than one document; for example, if "A" by letter offers to purchase property from "B" and "B" by letter accepts the offer, the two letters form a sufficient memorandum.

It is customary for agents to take a deposit of 10 per cent. of the purchase price and to give a receipt for such deposit, subject to a formal contract being entered into. When negotiations have been carried on between the parties without an agent it is advisable to stipulate that a formal contract shall be drawn up. This will enable the legal representatives for the parties to make the enquiries which should be made on behalf of every purchaser before a binding contract is entered into.

It should be noted that the mere payment or receipt of a deposit does not of itself bind either party. If there is no contract or memorandum in writing the party paying the deposit can refuse to proceed with the purchase and will be entitled to the return of his deposit; similarly the party receiving the deposit can change his mind and refuse to sell, but must then return the deposit.

Enquiries which should be made

The following are some of the enquiries which it is advisable for the proposed purchaser or his solicitor to make before a binding contract is entered into:—

(i) Are there any unusual outgoings such as tithe redemption annuity or land tax.

(ii) Have the plans of all buildings or any alterations thereto been passed by the local authorities.

(iii) In the case of a new house, whether the local authority

has given a certificate that the property is fit for habitation or a certificate as to a sufficient water supply.

(iv) Whether the road has been taken over by the local authority and all charges in respect thereof paid.

(v) Whether the property is subject to any restrictive covenants or stipulations as to the manner in which it may be used.

(vi) If the property has been let, particulars of the tenancies and of the standard rent according to the Rent and Mortgage Interest Restrictions Acts.

(vii) Particulars of the drains and sewers and whether there are any outstanding sanitary or other notices affecting the property.

(viii) Particulars of any easements, rights of way or rights or light affecting the property.

(ix) Particulars of the fire insurance.

(x) If the property is vacant land upon which it is intended to build, it is important to ascertain whether the property is affected by (*a*) the Restriction of Ribbon Development Act, 1935, which limits building on land abutting a classified road, and (*b*) whether the property is subject to any town planning scheme and, in particular, if there is a compulsory purchase order affecting the property.

Where property is to be sold at auction, the particulars of sale may contain some of the necessary information. A person who intends bidding at an auction can obtain information as to (ii), (iii), (iv), (vii) and (x) by enquiring of the local council and the county council within which the property is situate. As on a sale by auction a contract is made when the hammer falls, a proposed purchaser should obtain this information prior to the sale.

A formal contract, as well as containing particulars of the parties, description of the property and price, usually contains conditions on the following matters.

(*a*) The date upon which and the place where the sale and purchase is to be completed.

(*b*) The length of title to be shown by the vendor, i.e. for how far back the vendor must trace the title down to himself. If no length of title is referred to in the contract the vendor must show a title for thirty years preceding the contract, or in the case of leaseholds he must commence with the original lease, even

though it is more than thirty years old, and then show assignments of the lease for thirty years preceding the contract.

(*c*) The payment of a 10 per cent. deposit if this has not already been paid.

(*d*) The interest to be paid on the balance of the purchase money if the purchase is not completed on the day fixed for completion.

(*e*) Particulars of any restrictions, covenants, easements or rights of way affecting the property.

A contract for sale of land should be stamped with a sixpenny stamp. This may be an adhesive stamp provided it is affixed and cancelled at the time the agreement is signed, otherwise an impressed stamp is necessary.

It is usually provided, by the conditions of sale, on a sale by auction, that the highest bidder shall be the purchaser. The vendor may, however, fix a reserve price and withdraw the property, if not sold, without disclosing the reserve price.

If conditions of sale stipulate that the vendor reserves a right to bid, he or any one person on his behalf (known as a puffer) may bid, but if such a right is not reserved then neither the vendor nor any person on his behalf may bid. Even if a right to bid is reserved the vendor may employ only one puffer.

It is customary for the conditions of sale to provide that a deposit of 10 per cent. of the purchase price shall be paid immediately after the sale to the auctioneer. The auctioneer may take a cheque, but he is not bound to do so and may insist on payment in cash.

Immediately a valid contract for the sale and purchase of the property has been concluded, the beneficial ownership of the property passes to the purchaser, the vendor becoming a qualified trustee of the property for the purchaser. The vendor, however, has a right to retain possession of the property until the purchase is completed, and in the meantime, if the property is let, the vendor is entitled to receive the rent and profits; he must pay all outgoings in respect of the property until completion.

The vendor must take reasonable care of the property and will be responsible to the purchaser for any loss or damage which he, the vendor, ought to have prevented.

On the other hand, if the property is damaged or deteriorates between the time of the contract and completion, through no

fault of the vendor, e.g. by an act of God, the purchaser will still have to complete his purchase and suffer the loss. This is so even if the property is accidentally destroyed by fire, although in that case he may be able to obtain compensation from the vendor (see under Insurance, p. 77).

After the contract has been entered into, unless the contract otherwise provides (which is uncommon), the vendor must prove his title to the property. This is done by his solicitors delivering to the purchaser's solicitors a document known as an Abstract of Title. This document consists of an epitome of all the documents and facts showing the devolution of the property for the period provided for by the contract (or for thirty years if no period is fixed) down to the vendor. The purchaser's solicitors peruse the abstract to see that it shows a good title and examine the deeds with it, in order to see that the deeds are accurately abstracted.

When the title has been approved a formal deed (known as a Conveyance in the case of freeholds, an Assignment in the case of leaseholds and an Instrument of Transfer if the land is registered at H.M. Land Registry) is executed by the vendor and handed to the purchaser in exchange for the balance of the purchase money, after credit has been given for the deposit.

The payment must be paid either in cash or by a banker's draft. Cheques will not, except in exceptional cases, be accepted.

It is usual on completion for the outgoings payable on the property (i.e. General Rates, Water Rates, Schedule "A" Tax, Ground Rent (if any) and other payments of similar nature, to be apportioned up to date of completion.

When the purchase is completed the purchaser is entitled, in addition to the conveyance to him, to the deeds relating to the property in the possession of the vendor unless the deeds refer to other property which is retained by the vendor, in which case the conveyance to the purchaser should contain a covenant by the vendor to produce the deeds and to supply copies thereof to the purchaser if so required.

If the purchaser is raising the purchase money by means of a mortgage, the mortgagee will receive the deeds. The conveyance or other deed must be stamped within thirty days of the date of execution with the appropriate stamp duty (see Schedule, p. 67).

Purchaser going into possession before completion of purchase

It may happen that the purchaser wishes to enter into occupation of the property before the sale has been completed; if the vendor is willing, he may let the purchaser do so, but care should be exercised by both parties. The purchaser must take care that by so doing he does not waive any objection to vendor's title, whilst the vendor should be careful that by letting the purchaser into possession as a tenant pending completion the purchaser does not become a statutory tenant pursuant to the Rent and Mortgage Interest Restrictions Acts, in which case the vendor may experience great difficulty in obtaining possession from the purchaser if the sale is not completed.

In view of the decided cases on this question it is suggested that the proper course is for the parties to agree that the purchaser shall, on taking possession before completion of the purchase, not be deemed to have accepted the vendor's title and that the purchaser shall pay to the vendor interest on the balance of the purchase money and pay all outgoings pending completion.

The contract usually provides that if the purchase is not completed on the day fixed for completion, and the delay is caused other than by the wilful default of the vendor, the purchaser shall pay interest on the balance of the purchase money.

Breach of contract for sale

If the purchaser, in breach of the contract, fails to complete the purchase he will lose his deposit and may be liable for damage in a sum equal to the difference between the agreed price and the market price of the property. The vendor may on the other hand take proceedings for specific performance of the contract. If the vendor defaults, the purchaser is entitled, in the absence of agreement to the contrary, to the return of his deposit, interest on the purchase money, if he has kept it lying idle pending completion, and any expenses incurred in investigating the vendor's title. The purchaser also has the right to take proceedings for specific performance.

Registered land

In certain areas of England, the buying and selling of land has been greatly simplified by reason of compulsory registration of

title. Although registration is compulsory only in certain areas (the Counties of London and Middlesex and the County Boroughs of Eastbourne, Hastings and Croydon), owners of land elsewhere can voluntarily register their titles. In the compulsory areas, if the land is not already registered, any conveyance on sale, lease for a term of more than forty years or assignment of a lease with more than forty years unexpired at the date of the assignment, must be registered at H.M. Land Registry, Lincoln's Inn Fields, W.C.2, within two months of the date of the deed. Upon registration the owner of the property, who is known as the "Registered Proprietor," receives a document called a "Land Certificate."

On a sale of registered land, the usual contract is entered into and the title, which in most cases consists of a copy of the entries in the register at the Land Registry, and in the case of leaseholds a copy of the lease, is examined, but instead of a Deed of Conveyance a simple form of Instrument of Transfer is executed. This, together with the Land Certificate and the appropriate fee (see Schedule, p. 82), is lodged at the Land Registry and the purchaser is registered as the new registered proprietor.

In the majority of cases, the only document of title which the owner of registered land will have is the Land Certificate, but if the property is leasehold he should also have the original lease. If the registered land is mortgaged, the registered proprietor does not receive a Land Certificate, but the lender receives a similar document known as a Charge Certificate. When the mortgage or charge is paid off the lender hands over the Charge Certificate and an Instrument of Discharge to the registered proprietor who must lodge both documents at the Land Registry and will then receive a Land Certificate. No fee is payable when a discharge is registered.

In view of the simplification of the work involved, the solicitors' fees on dealings with registered land are considerably less than those on dealing with unregistered land.

For property in Yorkshire all deeds are registered at the Yorkshire Deeds Registry, but this is not a registration of land.

The following information gives would-be vendors or purchasers details of the fees and expenses involved in the sale of land.

Scale of Estate Agent's Fees on Commission

On negotiating a sale by private treaty or introducing a person able, ready and willing to purchase on terms authorised by the vendor, or

On a sale by auction including the preparation of particulars and advising as to a reserve price:

5 per cent. on the first £300.
2½ per cent. on the next £4,700.
1½ per cent. on the residue.

In addition, whether by private treaty or by auction, on amounts paid by the purchaser for chattels, fixtures, fittings, furniture or goodwill:

5 per cent. on the first £500.
2½ per cent. on the residue.

If the property is advertised to be sold by auction, but is sold before auction, the same fee as though sold by auction.

When property put up for auction is not sold, the fee is a matter of arrangement, but if the property is sold by the agent within three months from the auction, any charges for the non-sale merge into the ordinary commission then payable.

The agent's commission is payable by the vendor.

Notes

Stamp duty is payable by the purchaser.

The solicitor's scale charge does not include out-of-pocket payments for fares, searches, etc.

If the title deeds are not in the possession of the vendor or his solicitors a production fee of between one or two guineas may be payable.

If the purchaser is obtaining a mortgage, his solicitor is entitled to charge half-scale for work in connection therewith in addition to the scale fee on the purchase.

If the property is registered property and the purchaser obtains a mortgage there are the following abatements of Land Registry fees.

On a first registration, if a mortgage is registered at the same time no extra fee for the mortgage is payable.

On a transfer, if a mortgage is registered at the same time, half the scale fee is payable in respect of the mortgage in addition to the scale fee payable on the transfer.

STAMP DUTY COSTS AND FEES

Vendor's and Purchaser's

Purchase price not exceeding :	*Stamp duty.*	*Solicitor's charges.*		*Land Registry Fees.*	
		Unregistered land.	*Registered land.*	*Compulsory area.*	*Non-compulsory area.*
£	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
5	6	Minimum fee of 4 10 0			
10	1 0				
15	1 6				
20	2 0				
25	2 6			1 0	1 0
50	5 0		2 5 0	2 0	2 0
75	7 6			3 0	3 0
100	10 0			4 0	4 0
125	12 6			5 0	5 6
150	15 0			6 0	7 0
175	17 6	Minimum 7 10 0		7 0	8 6
200	1 0 0		2 5 0	8 0	10 0
250	1 5 0		2 16 3	10 0	13 0
300	1 10 0		3 7 6	12 0	16 0
350	1 15 0		3 18 9	14 0	19 0
400	2 0 0	9 0 0	4 10 0	16 0	1 2 0
450	2 5 0	10 2 6	5 1 3	18 0	1 5 0
500	2 10 0	11 5 0	5 12 6	1 0 0	1 8 0
550	5 10 0	12 7 6	6 3 9	1 3 0	1 11 0
600	6 0 0	13 10 0	6 15 0	1 6 0	1 14 0
650	6 10 0	14 12 6	7 6 3	1 9 0	1 17 0
700	7 0 0	15 15 0	7 17 6	1 12 0	2 0 0
750	7 10 0	16 17 6	8 8 9	1 15 0	2 2 6
800	8 0 0	18 0 0	9 0 0	1 17 6	2 5 0
850	8 10 0	19 2 6	9 11 3	2 0 0	2 7 6
900	9 0 0	20 5 0	10 2 6	2 2 6	2 10 0
950	9 10 0	21 7 6	10 13 9	2 5 0	2 12 6
1,000	10 0 0	22 10 0	11 5 0	2 7 6	2 15 0
1,050	10 10 0	23 5 0	11 12 6	2 10 6	2 17 6
1,100	11 0 0	24 0 0	12 0 0	2 13 6	3 0 0
1,150	11 10 0	24 15 0	12 7 6	2 16 6	3 2 6
1,200	12 0 0	25 10 0	12 15 0	2 19 6	3 5 0
1,250	12 10 0	26 5 0	13 2 6	3 2 6	3 7 6
1,300	13 0 0	27 0 0	13 10 0	3 5 6	3 10 0
1,350	13 10 0	27 15 0	13 7 6	3 8 6	3 12 6
1,400	14 0 0	28 10 0	14 5 0	3 11 6	3 15 0
1,450	14 10 0	29 5 0	14 12 6	3 14 6	3 17 6
1,500	15 0 0	30 0 0	15 0 0	3 17 6	4 0 0
1,550	17 10 0	30 15 0	15 7 6	4 3 0	4 6 0
1,600	20 0 0	31 10 0	15 15 0		
1,650	22 10 0	32 5 0	16 2 6	4 8 6	4 12 0
1,700	25 0 0	33 0 0	16 10 6		
1,750	27 10 0	33 15 0	16 17 6	4 14 0	4 18 0
1,800	30 0 0	34 10 0	17 5 0		
1,850	32 10 0	35 5 0	17 12 6	4 19 6	5 4 0
1,900	35 0 0	36 0 0	18 0 0		
1,950	37 10 0	36 15 0	18 7 6	5 5 0	5 10 0
2,000	40 0 0	37 10 0	18 15 0		
	Add £1 for every £50, or part of £50.	Exceeding £2,000 and not exceeding £3,000, add 15*s.* for every £50. £3,000 to £10,000, add 7*s.* 6*d.* for every £50.	Exceeding £2,000 and not exceeding £3,000, add 7*s.* 6*d.* for every £50. £3,000 to £5,000, add 3*s.* 9*d.* for each £50. £5,000 to £10,000, add 3*s.* for every £50.	Exceeding £2,000 and not exceeding £7,000, add 5*s.* 6*d.* for every £100, or part of £100. £7,000 to £10,000, add 4*s.* for every £100 or part of £100.	Exceeding £2,000 and not exceeding £10,000, add 6*s.* for every £100, or part of £100.

Mortgages

A mortgage is a method of securing the repayment of a debt. It consists of a personal covenant to repay the principal money, and at the same time secures the repayment by charging the land referred to.

Before 1925 the borrower (called the mortgagor) conveyed the property to the lender (called the mortgagee) retaining only a right to redeem the property upon repayment of the principal money, interest and costs. Since 1925 this method is changed so that the borrower now gives to the lender, in the case of freeholds, a lease for a long term of years or, if the mortgage is made by a document known as a "Charge by way of Legal Mortgage," an implied term of 3,000 years. In both cases the terms are automatically determined upon the payment off of the mortgage. A second mortgage of freeholds creates a term of one day longer than that created by the first mortgage. In the case of leasehold property the lender receives a sub-term of a few days less than the term of the original lease. A mortgage differs from a "pledge" in that when goods are pledged the borrower parts with possession of them; but in the case of a mortgage the borrower retains possession of the property so long as no default is made in repayment of the loan.

The main provisions of mortgages are framed on general lines. These are (1) a covenant to pay the principal money with interest at a certain date (known as the redemption date); (2) a covenant to pay interest at a fixed rate until payment if payment is not made on the redemption date; (3) the grant of a term of years, or a charge by way of legal mortgage of the mortgaged property; (4) provisions as to the termination of the term granted upon repayment of the principal money; and (5) covenants as to insurance, repairs and any special provisions agreed to between the parties.

The covenant to pay the principal money is a personal covenant independent of the property mortgaged, with the result that the borrower is liable thereunder even if the property ceases to exist, and may be sued accordingly.

That a date is fixed for payment does not mean that either party intends that payment shall be made on that date; but it is so fixed in order that if he so desires the lender may call for

payment on that date, or, if he so wishes, at any time thereafter. But the lender cannot demand payment before the redemption date, neither can the borrower insist that payment shall be accepted before that date. It is usual for the redemption date to be six months from the date of the mortgage deed.

It is common, especially in Building Society Mortgages for the principal money and interest to be payable by instalments so that provided the instalments are paid the principal money cannot be called in by the lender, but if default is made in the payment of any instalment the whole of the principal money became payable.

A mortgage may provide for a reduction in the rate of interest in the event of punctual payment; it may not, however, provide for an increase in the rate if prompt payment is not made. Any provision for an increase of this nature is treated as a penalty and is therefore void.

Right to redeem

In every mortgage the borrower has the right to redeem the property; any provision to the contrary is void. This right continues although default has been made in payment unless the lender has obtained a judgment for foreclosure or the property has been sold by the lender under his statutory powers, or by order of the Court.

As has been said, a borrower is not entitled to make repayment of the principal money before the redemption date, but if he does not do so on that day, unless the mortgage provides otherwise, he must give to the lender six months' notice of his intention of making repayment or pay six months' interest in lieu of notice. If, having given notice of payment off the borrower fails to do so at the time specified in the notice, the lender may insist on a fresh notice or further interest in lieu thereof. In the event of the lender giving notice to the borrower to repay, the lender is not entitled to six months' notice or interest, even although payment has not been made by the time stated in the notice; he is only entitled to interest up to date when payment is made.

Building Societies by their rules which are incorporated in their mortgages usually make provisions for repayment on short notice.

It is the custom that the borrower pays the survey and legal expenses of the lender in connection with the mortgage. Although this is so, the surveyor and solicitors employed by the lender, whether the lender be a private individual or a building society, are responsible to the lender alone, and they owe no duty to the borrower. The borrower has no right of action against them for any alleged negligence on their part.

The lender is entitled to have possession of the title deeds of the property.

Borrower's rights

Subject to any express terms contained in the mortgage a borrower or lender who is in possession (i.e. is in actual occupation or is in receipt of the rents and profits) has power to grant leases of the property, but the term must not be for longer than 50 years in the case of an occupation lease or 999 years for a building lease. Such a lease must be at the best rent which can reasonably be obtained without any premium being taken and must contain a condition whereby the landlord is entitled to re-enter upon the property if the rent is in arrear for a period of not exceeding 30 days. Further there must be a counterpart of the lease executed by the tenant.

Power of mortgagees

A lender has a number of statutory powers, the principal of which are:

(i) When the date for payment has passed and the mortgage money has become due, a power to sell the property, or to appoint a receiver of the rents and profits of the property.

(ii) A power to insure the property against fire up to the amount specified in the mortgage deed or if no amount is specified, up to two-thirds of the value of the property and to add the premiums to the mortgage money. This power cannot be exercised if the borrower has insured in accordance with the terms in the mortgage.

(iii) If he is in possession, a power of leasing above referred to.

A lender cannot exercise his power of sale, neither can he appoint a receiver unless either—

(*a*) he has given notice, and the borrower has made default in payment for a period of three months after service of the notice, or

(*b*) some interest under the mortgage is in arrear and unpaid for two months after becoming due, or

(*c*) the borrower has committed a breach of some provision of the mortgage other than a breach of the covenant to pay the mortgage money or interest, e.g. a breach of a covenant to keep the property in repair.

When a lender appoints a receiver, the receiver is deemed to be the agent of the borrower not of the lender who appointed him.

Where under his powers a lender sells the mortgaged property he must take reasonable precautions to secure a proper price and act in good faith. He cannot sell to himself either alone or jointly with another. But if he acts in good faith and prudently the Courts will not interfere if he sells at a price which the borrower considers insufficient. The sale may be at auction or by private treaty. If the sale produces more than sufficient to pay the lender all that is due to him he must pay the balance to the second or any subsequent lender if there be such or if there be no second mortgage, the balance must be paid to the borrower.

Should the proceeds of sale be insufficient to satisfy the mortgage debt, the lender is entitled to proceed against the borrower on his personal covenant for the balance.

Payment off of mortgage

As has been shown, a lender receives a term of years; upon payment of all principal money, interest and costs secured by the mortgage this term is automatically extinguished. The lender signs a document known as a "Statutory Receipt" which is usually endorsed on the mortgage deed. This receipt must show by whom the payment was made. Upon payment off the lender must hand back to the borrower all of the title deeds of the property.

A mortgage must be stamped with an impressed stamp for 5*s*. 0*d*. per cent. of the money advanced.

Building Societies

The general law as to mortgages applies to building societies, but for the protection of borrowers certain restrictions and duties are placed upon these societies by statute, for instance, after 1939:

(*a*) Where a society makes an advance to a member for the purchase of freehold or leasehold property, the society shall be deemed to warrant to the member that the purchase price is reasonable, unless before the contract for the advance is entered into the society gives to the member a notice in writing, stating that the making of the advance implies no such warranty.

(*b*) Where a society makes an advance to a member for the purchase price of freehold or leasehold land and takes any security for the advance from another person, then unless before the mortgage is entered into the society gives to the member notice in writing stating (i) the maximum amount which the society would have advanced upon the property without further security; (ii) the amount by which the advance exceeds that maximum; and (iii) particulars of the further security which is to be taken, no sums can be recovered by the society in respect of the advance, nor can the society exercise any of its rights under the mortgage without the leave of the Court.

(*c*) If a society in exercise of its powers, sells the property, the society must take reasonable care to ensure that the price at which the property is sold is the best price which can be reasonably obtained.

Building Bye-laws

The Public Health Act, 1936, provides that local authorities may, and if required by the Minister of Health so to do must, make bye-laws with regard to the construction of buildings within its jurisdiction.

The bye-laws should relate to the material to be used, the surrounding space, lighting and ventilation, dimensions of rooms intended for human habitation, height of buildings, sanitary arrangements and drainage, cesspools, water supply, heating and means of preventing fire.

These bye-laws are not limited merely to the erection of new buildings of a permanent nature, but extend to alterations,

additions, and temporary erections including large sheds (usually if they exceed 6 ft. in height). It is often provided that a new house shall not be occupied until the local surveyor certifies the drainage to be complete or that there is a sufficient supply of water.

Usually the bye-laws provide that plans and specifications of the work to be carried out shall be deposited with the local authority for approval. If the plans are so deposited, the local authority must notify the person depositing them whether or not they are passed. If work is carried out in breach of the bye-laws the local authority can insist on the work being pulled down or altered so as to comply with the bye-laws and can also take summary proceedings for a fine. A notice requiring the work to be pulled down must be given within twelve months from the date upon which the work was completed.

If although the bye-laws are infringed the plans had been passed, or having been deposited were not rejected, the local authority later applies for the removal of the building, the owner may be entitled to compensation from the local authority.

When plans have been deposited and approved, the work must be commenced within three years from when they were deposited, otherwise the local authority may give notice that the deposit is void and a new deposit must be made before the work is commenced.

In some circumstances, such as when a building is to be constructed of materials which are not suitable for permanent structures, the deposited plans and specifications may be passed with a condition imposed that the building is to be removed at the end of a fixed period and also a condition as to the manner in which the building may be used.

If the owner fails to remove the building at the expiration of the period or uses the building for a purpose other than that authorized, the local authority may remove the building, and the owner is liable to a penalty of Ten Pounds.

Proper provision for escape in case of fire must be provided if a building is more than two storeys high and the floor of the top storey is more than 20 ft. from ground or street level, and such building is intended to be used as flats, boarding-house, hotel, boarding-school or for similar use.

It is an offence to erect any building over a public sewer.

Restrictive Covenants

When the owner of land sells part of it and retains the rest, he may stipulate that the purchaser of the part sold shall enter covenants which restrict his right to use the land for specific purposes. This the owner does so that the value of the remaining land shall not be depreciated by the use to which the purchaser might put his land. For instance, the person who is selling may insist that the purchaser shall only use the land for the purpose of building a dwelling-house or that only buildings of a certain minimum value shall be erected or that no trade or business which shall become a nuisance to adjoining property shall be carried on upon the land. This type of restriction is often placed upon purchasers when a new estate is being developed in a residential area and is known as "a building scheme." Every purchaser of a house on the estate enters into an identical covenant.

If the owner of land sells all his land to the same purchaser, and in the conveyance the purchaser enters into a restrictive covenant, then the covenant is merely personal, i.e. it will not be enforced against a purchaser from the original purchaser. But when a new estate is being developed it is common for each purchaser of a house or plot to enter a covenant in similar terms to the other purchasers. This is for the benefit of the estate as a whole. In such a case one purchaser can enforce the covenant against another, and any person who afterwards purchases from an original purchaser can enforce the covenant against the other owners of adjoining or neighbouring land on the estate.

It should be pointed out that for a covenant to be enforceable by or upon subsequent owners of the land it must be a restrictive and not a positive or affirmative covenant. For instance, if A sells land to B and B enters into a covenant that he will erect and maintain a fence, A cannot enforce the covenant against C, a Purchaser of the land from B.

Provision has been made whereby in certain circumstances restrictive covenants may be wholly or partially removed from the land affected by them. It is provided by section 84 of the Law of Property Act, 1925, that any person interested in land, that is a freeholder or a leaseholder of a lease for more than seventy years with fifty years unexpired may apply to an

"Official Arbitrator" to have the restrictions as to the user of the property discharged or modified if (1) by reason of changes in the character of the neighbourhood the restriction should be deemed to be obsolete; (2) the persons entitled to the benefit of the covenant (that is, entitled to enforce it) being of full age and capacity have either expressly or impliedly agreed to the restrictions being modified or discharged; or (3) that if the restrictions are discharged or modified the person entitled to the benefit of the covenant will not be injured thereby.

These provisions are useful in such cases as where premises are subject to a restriction that they shall be used as a private dwelling-house only, and by reason of a change in character of the neighbourhood it would be of advantage to the owner of the premises if he could convert them into flats or business premises.

Fixtures

In cases of both freehold and leasehold property, differences often arise on the question of fixtures.

On the purchase of freehold property, fixtures form part of the property sold and must not be removed by the vendor unless the contract so provides.

In the case of leaseholds, the question arises at the termination of the lease, as to whether articles affixed to the premises by the tenant during the term of the lease can be broken away by him or not. For ordinary purposes those fixtures which must be left are called "Landlord's fixtures," and those which can be taken by the tenant "Tenant's fixtures."

In deciding whether an article is a landlord's fixture or not, the main facts are (i) the object or purpose of the fixture and (ii) whether it can be removed without doing irrepairable damage to the premises.

Anything fixed to premises for the permanent improvement of the premises, will be classed a landlord's fixture, but if it is fixed merely for ornamental purpose or for domestic convenience it will not.

The mere fact that an article is annexed to the property will not of itself make it become a landlord's fixture, although the degree of annexation is taken into account. Similarly, an article does not become a landlord's fixture merely because some

damage would be caused to the property upon its being attached; but if irrepairable damage would be caused, then the article must be left. Further, a tenant must repair any damage caused by the removal.

The following are some articles which have been held to be removable: ovens, coppers, cupboards which stand on the ground and are fixed to the walls for stability, stoves and grates which can be removed without injury to the chimney, gas fires and electric and gas fittings.

As to business premises, articles which have been attached so as to become fixtures can be severed and removed from the premises if they were affixed for the purpose of trade.

A tenant, if he has a right to remove fixtures, must do so before the end of the tenancy, otherwise they become the property of the landlord.

Income Tax

Income tax is payable in respect of the ownership of lands and buildings, because such tax is assessed pursuant to the provisions of Schedule "A" to the Finance Act, 1918, it is commonly known as Schedule "A" Tax or "Landlord's Property Tax."

Whether a house is owner-occupied or is let, the basis of the assessment is the same, namely, the annual value, i.e. rack-rental value of the house.

If a house is owner-occupied, the owner does not receive any cash income from the property, but the law assumes that he has derived an income from it to the extent of the annual value. In this case the annual value is that at which the house is worth to be let based upon the rents of similar properties in the district.

In the case where a house is let, the annual value is equal to the rack rental value, i.e. the best rent obtainable without taking a fine on the assumption that the landlord is liable to do repairs and the tenant pays the rates.

The annual value as stated above forms the gross assessment. From the gross assessment an allowance for repairs is automatically deducted thereby arriving at the net assessment upon which tax is charged. The allowance for repairs is calculated as follows: Where the gross annual value is under £40, one-quarter is allowed; on gross values between £40 and £100

one-fifth; and on gross values exceeding £100, £20 plus one-sixth of the excess of £100.

If it can be shown that the average yearly expenses paid for repairs, and maintenance and insurance to property, have for the five preceding years exceeded the above-mentioned statutory allowance, then a claim may be made for repayment of tax paid on the excess.

As has been pointed out the gross value is the income which is deemed to have arisen from the property. If, however, the property is mortgaged, then, clearly, the interest payable on the principal sum advanced, is a charge, which has to be set against such income.

In such cases the result is that tax is payable only on the difference between the amount of the mortgage interest and the net assessment, e.g. if the net assessment of a property is £25 and the property is mortgaged for £600 with interest at 4 per cent. then tax will be payable on £1, the difference between £25, the assessment and £24 the interest payable to the mortgagee. Should the annual interest exceed the net assessment an allowance in respect of the excess is made against other sources of income.

Schedule "A" Tax is not payable on vacant property.

This tax is collected from the occupier, except in a few cases, when it is collected from the landlord. It is collected from the landlord (*a*) when it is in respect of a dwelling-house of an annual value of less than £10; (*b*) in respect of lands or buildings let for a period of less than one year; (*c*) in respect of buildings let in different tenements; and (*d*) where the landlord applies for the assessment to be levied upon himself.

A tenant who has paid the tax may deduct the same amount from the next payment of rent.

When property is let at a rent in excess of the annual value the owner is assessed under Schedule "D" upon the excess.

Fire Insurance

A contract of fire insurance is a contract of indemnity, i.e. the assured cannot recover under the contract unless he has suffered some pecuniary loss as the result of the happening of a certain event. He cannot recover more than the sum insured.

As a contract of insurance is a contract based on the utmost of good faith the assured is bound to disclose to the insurers all material facts, otherwise the insurers may be entitled to avoid the contract. Any fact which, if known to the insurers would have effected the minds of the insurers, is a material fact.

A person cannot recover under a fire insurance unless he has an insurable interest in the subject-matter.

A vendor of property has an insurable interest until the property has been conveyed to the purchaser.

A purchaser has an insurable interest immediately he has entered into a contract to purchase.

If the property is accidentally burnt down between the date of the contract and the time when the purchase is completed, the purchaser will have to perform his contract. If the vendor has insured the property, the purchaser has no claim against the insurance company under that insurance unless he has had his interest noted in the company's books; nor has he any claim against the vendor in respect of any money which the vendor may receive under his policy unless the requisite consent of the insurers has been obtained if required. Some policies provide that the company will recognize the interest of a purchaser pending completion without formal application being made; but it is a wise precaution for every purchaser immediately a contract to purchase has been entered into, either himself to insure, or to ask the vendor's insurers if they will hold his interest covered pending completion.

It is essential that there shall be ignition in order to claim under a fire policy. Damage caused by excessive heat without ignition does not fall within the meaning of damage by fire. In most cases, it is immaterial whether the cause of the fire was accidental or due to negligence, and the insured is entitled to recover in either case.

It is usual for a fire policy to contain a number of excepted perils; if a fire is caused by any such excepted peril the assured cannot claim under the policy.

The amount specified in the policy as the sum insured is the maximum sum which the assured can recover, even though the amount of his loss exceeds that sum. No allowance can be claimed for loss of profits.

Usually fire policies contain a clause (known as an "average

clause") providing that, if at the time when the loss is suffered, the value of the property is greater than the sum insured, the assured is to bear a rateable proportion of the loss. Similarly, in most proposal forms for a "Comprehensive Policy" the applicant declares that the sum insured is the full value of the property. In either of these cases, if there is any doubt as to the correct value of the property, the person proposing to insure should have the property valued by a competent valuer.

In some leases it is provided that in the event of the premises becoming uninhabitable by reason of damage by fire, the rent shall not be payable until the damage has been repaired; if there is no such provision, the tenant remains responsible for the rent although he cannot occupy the premises. For a small premium this risk can be insured against.

Rates

Rates have been defined as "imposts which are levied by local authorities on persons occupying property situated within the area of the local authority for the payment of expenses incurred on services locally administered."

Outside of the metropolis the council of every County Borough, Urban District and Rural District is the rating authority for the borough or district.

In the metropolitan area the council of any metropolitan borough is the rating authority.

The rating authority levies a general rate which is at a uniform amount per pound on the rateable value of the premises. Rates are levied on lands, tenements or property such a harbours, docks, mines, brickfields and gravel pits, etc., but for the purpose of this article the references are to dwelling-houses.

In rural areas the rating authority may make a special rate in respect of expenditure for lighting or for any special expenses to be incurred under the provisions of the Public Health Acts. A special rate is made for a specific period.

No rates are payable in respect of unoccupied property, but if premises have been left unoccupied in order that they might be let furnished, or seaside boarding-houses not used during the winter, rates are still payable.

As has been said, a rate is based upon the rateable value of the

property. The rateable value is usually the net value, which is assessed as follows:

Outside London. The gross value is the rent at which the property might reasonably be expected to let from year to year if the tenant undertook to pay all usual tenant's rates and taxes and tithe rentcharge, if any, and if the landlord undertook to bear the cost of repairs and insurance and other expenses, if any, to maintain the premises in a state to command that rent. Provided no account is taken in value of any services which the landlord renders or procures to be rendered to the tenant, other than the provision of repairs, etc.

To obtain the net value the following deductions are allowed from the gross value:

Houses and buildings without land other than gardens, where the gross value does not exceed ..	£10	An amount not exceeding 40 per cent. of the gross value.
ditto ditto	£20	£4 or 33⅓ per cent. of the gross value, whichever is the greater.
ditto ditto	£40	£7 or 25 per cent. of the gross value, whichever is the greater.
ditto ditto	£100	£10 or 20 per cent. of the gross value, whichever is the greater.

In London. The gross value is the annual rent which a tenant might reasonably pay on similar terms to those mentioned above. The net value is obtained by deducting from the gross value the probable annual average cost of repairs, insurance and expenses with the following maximum deductions:

Houses and Buildings without land other than gardens, where the gross value does not exceed ..	£15	An amount equal to $\frac{2}{5}$ of the gross value.
ditto ditto	£20	£6 together with an amount equal to $\frac{3}{16}$ of the amount by which the gross value exceeds £15.
ditto ditto	£40	£7 together with $\frac{1}{4}$ of the amount by which the gross value exceeds £20.
ditto ditto	£100	£12 together with $\frac{1}{5}$ of the amount by which the gross value exceeds £40.

All property must be assumed to be let, therefore when it is owner-occupied the owner is assumed to be the tenant.

In every fifth year (postponed during the war) every rating authority must deposit at the offices of the authority and with the assessment committee a valuation list for the property in its area. Public notice of the deposit must be given. Within twenty-five days after the list has been deposited, any person who feels aggrieved by reason of the unfairness or incorrectness of the valuation may serve a notice in writing objecting to the assessment. The notice must state the grounds of the objection and the correction desired. The assessment committee must meet to hear objections. The objector is entitled to be heard on the hearing. After determining the objection the assessment committee must send notice of its decision to the objector and to the rating authority.

Rates are payable by the occupier of the property, but in certain circumstances (in the case of small property) the rating authority may collect the rate from the owner instead of the occupier. If in these circumstances the owner fails to pay the rate, the rating authority may demand the rate from the occupier, and if the occupier fails to pay, the authority may levy distress on the goods of the occupier. But distress can only be levied for the amount of rate which has accrued due during the time the occupier has been in occupation. The occupier is thereupon entitled to deduct the amount paid from the rent payable to the owner.

Landlord and Tenant

A lease or tenancy agreement for a term not exceeding three years may be made either orally or by a written document under hand only. All leases for a period exceeding three years must be made by a deed. Every lease should state the name of the landlord and of the tenant, a sufficient identity of the property let, the date upon which the term is to commence, the length of the term and the rent payable. It is usual for the lease to contain covenants as to the liability to carry out repairs and the manner in which the property is to be used.

Leases must be stamped in accordance with the following scale:

(i) For any definite term not exceeding a year of any dwelling-

house or part of a dwelling-house at a rent not exceeding Forty Pounds per annum, 1*d*.

(ii) For any definite term less than a year of a furnished dwelling-house or apartments where the rent for the term exceeds Twenty-five Pounds, 5*s*.

(iii) For any other definite term or for any indefinite term as follows:

Rent.	*Term not exceeding 35 years.*			*Term exceeding 35 years but does not exceed 100 years.*		
	£	*s.*	*d.*	£	*s.*	*d.*
Not exceeding £5 per annum.		1	0		12	0
Exceeding £5 and not exceeding £10 p.a.		2	0	1	4	0
„ £10 „ „ £15 p.a.		3	0	1	16	0
„ £15 „ „ £20 p.a.		4	0	2	8	0
„ £20 „ „ £25 p.a.		5	0	3	0	0
„ £25 „ „ £50 p.a.		10	0	6	0	0
„ £50 „ „ £75 p.a.		15	0	9	0	0
„ £75 „ „ £100 p.a.	1	0	0	12	0	0
„ £100 for every £50 and part of £50	1	0	0	6	0	0

Where there is an initial lump sum payment as well as a rent, stamp duty is payable on the initial payment at the same rate as shown in the second column of the table on p. 67.

In certain cases there is imposed upon the landlord a statutory duty to repair. The Housing Act, 1925, provides that where a dwelling-house is let at a rent, in London of not more than £40 per annum, or elsewhere not more than £26 per annum, there is an implied condition that at the commencement of the tenancy the house is in all respects reasonably fit for human habitation, an exception is made when a house is let within these limits for a period of three years or more and the tenant has agreed to put it into a reasonable fit condition; a further condition is implied that the landlord will, during the continuance of the tenancy, keep the house in all respects reasonably fit for human habitation. There is an implied condition on the letting of a furnished house that it is in a fit state for habitation.

Except in the cases above referred to, and in the absence of any express stipulation or covenant, a landlord is not bound to put the premises into repair at the commencement of the term, neither is he liable to carry out repairs during the tenancy.

In the absence of specific covenants a tenant has the implied obligations of paying the rent, not to permit waste, and to allow the landlord access for the purpose of inspecting the state of repair of the property. Waste is divided into two classes, voluntary and permissive; the former includes such acts as destroying any part of the premises or making any alterations to them. Permissive waste is failure to carry out such repairs as may be necessary to stop injury or damage to the premises by exposure to the elements and defects of the premises. A tenant from year to year is only bound to keep the premises wind and watertight.

It is usual for a lease to contain specific covenants as to repairs. When a lease specifies the manner and extent of the repairs and decorative work which must be carried out during the tenancy and upon giving up the premises, the tenant is bound to comply with the covenant or (except in certain circumstances mentioned below) he will be liable for a claim for dilapidations during the term or damages after its termination.

A covenant containing the phrase "habitable repair" or "good repair" or "good and tenantable repair" or "substantial repair" means such repair as, having regard to the age, character and locality of the premises would make them reasonably fit for the occupation by a new tenant of a class who would have been likely to live in them, at the commencement of the tenancy. But a tenant is not, by reason of such a covenant necessarily bound to paint and repair the whole of the premises at the termination of the term.

If the covenant provides "reasonable wear and tear excepted" the tenant is not responsible for damage caused by the ordinary reasonable user or by exposure to the elements.

A tenant who has to deliver up premises in a stated condition of repair must carry out the necessary repairs before the termination of the term. He has no right to enter the premises himself or by his workmen after the termination. If he has failed to comply with the covenant he will be liable in damages to the extent of the amount which the landlord has suffered by reason of repairs not being carried out, which is usually the cost of carrying out the repairs. If, however, the tenant can show that at or shortly after the end of the tenancy the premises had been or would be pulled down or such structural alterations made as would render the repairs, if they had been carried out, valueless,

then the landlord cannot recover any damages in respect of the breach of covenant.

Unless the covenant to repair excepts damage by fire, a tenant is bound to repair, and, if necessary, rebuild the premises if they are damaged or destroyed by fire.

Another usual covenant is one which provides for the manner in which the premises are to be used. A covenant that premises are to be used as a private dwelling-house is broken if they are converted into flats or used as apartments or for the purpose of taking in paying guests or lodgers; the showing of an advertisement or trade plate would constitute a breach of such a covenant.

A covenant that the tenant shall not assign or underlet without the previous consent of the landlord, is deemed to be subject to a provision that the landlord shall not unreasonably withhold his consent. If, therefore, a tenant who is subject to a covenant of this nature wishes to assign or sub-let to a respectable and responsible person, the tenant should apply to the landlord for his consent, and if the consent is refused the tenant is at liberty to assign or sub-let without the landlord's consent.

Upon an assignment of a lease by an original tenant, he remains liable to the landlord upon all the tenant's covenants contained in the lease; he has, however, a right of indemnity against the person to whom he assigned. The landlord can sue either the original tenant or the assignee. The liability of the assignee is limited to claims which have arisen during the time he was the tenant.

A lease for a term of years obviously terminates at the end of the specified term. Periodic tenancies such as monthly, quarterly or yearly tenancies can only be determined by either party giving notice to the other.

To determine tenancies less than yearly tenancies the notice must be of the same length as the tenancy, to expire at the end of a completed period; for example, to terminate a quarterly tenancy a quarter's notice expiring at the end of a completed quarter must be given. In the case of yearly tenancies (except agricultural tenancies) the notice can be a six months' notice ending at the termination of a complete year.

Owner's liabilities to Third Persons

The owner or occupier of property cannot use it in any manner he may wish without having regard for his neighbours. In any

civilized community it is necessary in order that all can live in reasonable comfort, that owners of property of any nature shall use it in a reasonable and ordinary manner. Similarly, an owner of property cannot demand that he shall be caused no inconvenience by the reasonable use of his neighbour's land.

There must be "give and take" between neighbours, otherwise the ordinary commonplace domestic and commercial life of the community could not be carried on. Over the years, the Courts and Parliament have made numerous rules and regulations governing the use and occupation of property.

It is proposed to deal shortly with some of these rules and regulations.

The extent of the liability of an occupier of premises in respect of damage caused to a person coming upon the property depends upon whether such person was (*a*) an invitee; (*b*) a licensee; or (*c*) a trespasser.

(*a*) An invitee is a person who comes on to the premises at the invitation of the occupier expressed or implied in the course of business in which the occupier has an interest. To this class of person, the occupier of premises has the greatest responsibility. He has a duty to use reasonable care to prevent damage from any unusual danger of which he knows or ought to have known, but which is unknown to the person invited on to the premises. The occupier is not responsible for injury caused through some defect of which he did not know and of which he would not be reasonably expected to have known had he taken reasonable care.

(*b*) A licensee is a person who comes upon the premises with the permission of the occupier, but not for any business in which the occupier is interested, and guests. To this class of person the occupier is not bound to see that the premises are safe. A licensee must take the premises as he finds them. But the occupier will be liable for any injuries received by a licensee by reason of a concealed danger known of by the owner and not by the licensee, or by a trap. In this connection the Courts have decided that an owner must take more care of children who are licensees than of adults, as some dangers which would be obvious to an adult would not be so to a child.

(*c*) To trespassers an occupier owes no duty except that if he knows the trespasser is present he must not do any act with

the intention of causing him injury or which if done carelessly would be expected to injure him, and an occupier who intentionally creates a source of danger on his land for the purpose of causing injury to a trespasser, e.g. allowing a vicious dog to roam at large or the setting of man-traps, will be liable for any injury so caused.

Trespass by animals

Except in the case of cats and dogs which are usually harmless and difficult to prevent from trespassing, the owner of an animal is liable for any damage caused by its trespass. The owner of a cat or dog will be liable, however, if he knew the animal was of a mischievous disposition and was likely to cause damage if it trespassed.

But if an owner of adjoining land is under a duty to the owner of the animal to fence the adjoining land and allows the fence to become in such a state of disrepair that it is possible for the animal to trespass, then the owner of the animal will not be responsible for its trespass on the land. Further, the landowner who, being under a duty to maintain a fence, allows it to become into such a state of disrepair that his neighbour's animals trespass, may be liable in damages to the animal's owner for any injury suffered by the animals through the trespass; e.g. through eating something poisonous during the trespass.

Keeping animals

Local authorities have power to make bye-laws preventing the keeping of animals likely to cause a nuisance provided such bye-laws are reasonable to keep animals so that they cause no undue annoyance either to the general public or to a private individual.

Damage by animals

For this purpose animals must be divided into two classes: (i) Wild animals such as tigers, bears or monkeys which are obviously dangerous by nature, although some have been tamed; (ii) Domestic animals (which include dogs, cats, horses and bulls) which are not naturally dangerous to mankind.

An owner of an animal of the first class keeps it at his peril, even although he believes it to be tame. If the animal escapes from control and does damage, the owner is responsible.

The owner of a domestic animal is in a different position. He will not be liable for damage caused by the animal unless (i) he knew the animal had the tendency to cause the damage complained of, or (ii) he has been negligent.

The owner of a cat that went on to a neighbour's land and killed fowls and pigeons was held not to be liable for the damage done by the cat because there was no evidence that the cat had previously shown any mischievous tendency.

Further, if it is alleged that the animal's owner knew of its mischievous tendency, before he can be responsible for any damage caused by it, it must be proved that the animal was likely to do the sort of damage it did. For example, the fact that the owner of a dog knew it had attacked another animal, does not make him responsible if the dog attacks a human being. It is this rule which gives a dog its "first bite." The same principle applies to all domestic animals.

If the owner of a dog gives warning to keep away from it, the warning is evidence that he knew of its tendency to bite.

An owner who has properly secured an animal is not responsible to a trespasser or to any person who brings injury upon himself. Therefore an owner of a vicious watch-dog, if it is properly secured, is not liable for any injuries to a trespasser; but he would be liable if the dog attacked someone who came lawfully upon the premises.

By the Dogs Act, 1906, as amended by the Dogs (Amendment) Act, 1928, the owner of a dog is responsible if the dog attacks cattle or poultry, whether or not he knew of tendency to do so. In these two cases a dog is not entitled to its "first bite."

Vermin

By statute, it is an offence if the occupier of premises does not take the necessary steps to destroy rats and mice on his property. Further, a person is liable, if by reason of extraordinary use of his property, he attracts rats, mice or flies so that injury is caused to his neighbours. What is extraordinary user is a question of fact in each case. It has been held that an excessive heap of bones or manure is not ordinary user.

Fire

Originally, a man was liable for any damage caused by fire to the property of another merely if the fire originated on his property and escaped to the property of the other. But now, before he can be liable for damage, it is necessary for the fire to have been caused by his negligence or the negligence of his servants, or that the fire was caused by reason of something dangerous in itself which he has placed upon his property. For instance, a bonfire may not of itself be dangerous, but if I make a bonfire so close to my neighbour's fence that it spreads and damages the fence, I will be liable for the damage.

It has been held that a motor car having petrol in its tank is a potentially dangerous thing, with the result that if it caught fire and damaged property of another the owner of the car would be responsible for the damage caused.

Trees

If the owner of land allows his trees to spread over adjoining land he is liable for damage caused thereby. Some trees, such as yews, are poisonous; if such a tree overhangs a neighbour's land, and the neighbour's animals are poisoned by eating it, the owner of the tree will be responsible. Similarly, if the neighbour's crops are injured by an overhanging tree, the owner of the tree is liable.

A person who suffers by reason of overhanging trees may abate the nuisance by cutting off the offending branches. If he can do so from his own land, he need not give any notice of his intention to cut back the tree to the tree owner; but if he cannot abate the nuisance without himself trespassing on his neighbour's land, he must first give his neighbour notice to remove the offending branches.

In any event, he must not cut more of the tree than is actually overhanging. Further, when the overhanging branches have been cut off they do not belong to the owner of the land over which they were hanging; neither does any fruit which may be on them. They remain the property of the owner of the tree.

Under the Public Health Act, 1925, if any tree, hedge or shrub overhangs a street or footpath so that it (*a*) obstructs or interfered with the light from a public lamp, (*b*) endangers or

obstructs the passage of vehicles or foot passengers, or (*c*) obstructs the view of drivers of vehicles, the local authority may serve a notice upon the owner or occupier requiring him to lop or cut down the tree, hedge or shrub within fourteen days. If the notice is not complied with, the local authority can do what is necessary and recover the cost from the person served with the notice.

An owner of a tree which falls into the highway causing damage will only be liable for the damage if he knew, or with reasonable care could have known, of its dangerous condition.

It has been held that where the roots of a tree penetrated into neighbouring land and thereby caused damage to buildings on such land, the owner of the tree was liable for the damage.

Weeds

At common law there is no duty upon an occupier of land to cut down weeds naturally growing on his land, so as to stop them seeding on adjoining land. By statute, however, the Minister of Agriculture has power to serve upon the occupiers of land upon which there are growing certain specified weeds, namely, spear thistle, creeping thistle, curled dock, broad-leaved dock and ragwort, a notice requiring him to cut down and destroy such weeds within the time and in the manner specified in the notice.

If a notice is served upon a tenant, it must also be served upon the landlord.

If an occupier of land who, having been served with such a notice, unreasonably fails to comply therewith, he becomes liable to a fine not exceeding £20 and to a further fine not exceeding 20*s*. for every day that he fails to comply with the notice after the conviction.

Fences

At common law a man is not bound to fence his land, but he is bound to keep his animals from trespassing on his neighbours land. He may be required to do so by condition attaching to the land, and in certain circumstances is by statute bound to do so.

If any land adjoining any street is allowed to remain unfenced or has fences which are in disrepair, and by reason thereof is a source of danger or inconvenience or annoyance to the public, the local authority may apply for an order enabling them to require the owner of the land either to fence it or to repair the fences.

Similarly, if any building, excavation, pond, stream or bank is dangerous to the public using any street or footpath for want of enclosure, the local authority may, by notice in writing, require the owner to enclose the property.

Barbed wire must not be used in the construction of a fence along a highway if it is likely to be injurious to persons or animals lawfully using the highway.

If a person lawfully using the highway suffers injury by reason of defect in a fence along the highway, the occupier of the premises will be liable in damages for the injury.

A gate or door must not open out on to a highway.

It often happens that disputes arise between adjoining owners as to whose liability it is to repair and maintain a dividing fence. In the case of leasehold property, the lease usually contains a covenant on the part of the lessee to repair, or where the same person is lessor of both properties, the lease may provide that the dividing fence is a party fence repairable jointly by the adjoining owners, each paying a fair proportion of the cost of repair.

In freeholds it is unusual for fences to be party fences. The conveyance may state which fences belong to the property, or a plan to the conveyance may show, by means of "T" marks, to which property the fence belongs. If the plan shows a "T" standing on a boundary line the fence belongs to the property on the side upon which the "T" stands.

The fact that an owner of land has for many years done slight repairs to a fence between his land and adjoining land does not necessarily infer that he is legally bound to repair; he may have carried out the repairs for his own convenience.

But if upon notice from the adjoining owner requiring repairs to be carried out, he and his predecessors have always done the necessary repairs, then a legal obligation to repair will be inferred. In the absence of such inference or an express agreement to maintain a fence, the owner of land is not bound to

repair a dividing fence. He must keep his animals from damaging his neighbours land, and if having erected a fence he allows it to become in a state of disrepair he will be responsible for any damage caused through the disrepair, for example, if the fence, through neglect, collapses on to his neighbours land and thereby damaging his neighbour's crops.

Rights of Way and Light

Rights of way

A right of way is a right to pass and repass over land which belongs to another person. If the general public are entitled to use it, it is a public right of way; on the other hand, if the right of way is enjoyed only by the owners or occupiers of a particular building or buildings it is a private right of way.

A right of way may be created by a deed, or may be acquired as of necessity, or by long user, i.e. when a person or persons have for a number of years enjoyed a right over land which belongs to another with his knowledge but not by agreement or licence.

A right of way claimed by reason of long user can only be claimed in respect of the manner in which it has been used over the period of years; for instance, if a person or persons as owners of property have a right, by reason of long user, to walk across a field by means of a defined path, it does not mean that they have a right to ride a horse or motor-cycle over the path. When a right of way is claimed as having been granted by a deed. the manner and extent to which the right can be used depends upon the words used in creating it. The right may be one merely to use the way as a footway or as a general right of way according to the circumstances, and the nature of the property to which the right of way is attached.

A grant (without any words of limitation) of a right of way to a private dwelling-house, over a road which has not been taken over by the local authority gives to the occupier of the house a right of way for all reasonable purposes required by the house, including the right for horses, carts, cars and general traffic.

Similarly where a right of way is granted over a strip of land running from the highway along the rear of houses abutting the highway, if the strip of land is reasonably capable of being used

as a means of access by car, a right of way for this purpose will be assumed to have been granted unless it was otherwise limited by the deed creating it.

Generally a right of way to a private dwelling-house may be exercised by the occupier, his servants, guests and tradespeople.

It is usual when the right of way is granted by deed, for the deed to provide as to the extent to which the person having the right shall be liable for its maintenance and repair. When adjoining owners have similar rights over the same way it is common for such owners to be liable for a proportionate share of the cost of repair. If the deed is silent as to this liability, the person entitled to use the way must do such repairs as he thinks necessary. He has no claim against the person by whom the right was granted or against the owners of adjoining or neighbouring property who have a right to use the same way.

A right of way, from its nature, does not confer upon the person entitled to the right exclusive use of the way. But he is entitled to use without the wrongful interference by others. Substantial interference with the way which renders it unfit for the purpose for which the right of way was granted, is unlawful and a nuisance at law.

A person entitled to a right of way may remove an obstruction which is a nuisance, provided he has given the person responsible for the obstruction proper notice and has requested its removal. He is also entitled to sue for damages or for an injunction to restrain obstruction of the way.

Excessive user of a right of way is a trespass. A person so using a way may be restrained from doing so by action brought by any other person having a right to the way, or by the person who granted it.

Right of light

A right of light, or, as it is commonly called "ancient lights," is a right which an owner or occupier of a building may acquire whereby the owner or occupier of adjoining land is prevented from erecting anything which has the effect of obscuring or obstructing the light coming to the building.

A right of this nature may be granted by deed; but is more usually acquired by implication of law or pursuant to the *Prescription Act*, 1832.

Prescription Act, 1832

"A" owns a house with land adjoining and sells the house to "B," retaining for himself the land; unless A in the conveyance to B reserves a right to build on the land, B acquires a right that A shall not obstruct the light to the house by anything to be erected on the land.

By the Prescription Act, 1832, if a building has had access of light for an uninterrupted period of twenty years, not having enjoyed it by leave or licence, then an absolute right of light is acquired. The result is that no erection can be placed on adjoining land which would interfere with the light enjoyed by the building to an extent which would cause a nuisance.

A right of light cannot be acquired in connection with a piece of open land, but can only be acquired in respect of a building.

When a right of light has been acquired, it does not mean that no interference is possible. The mere fact that less light is available is not of itself sufficient to cause an illegal obstruction.

There is no fixed rule of thumb method of calculating what amount of light a building is entitled to; but it has been decided that where a right of light has been acquired a building is entitled to light through the windows for the ordinary comfortable use and enjoyment of the building. If this amount of light is left to the building then a right of light has not been unfringed, even though the building does not get the same amount of light as it did before any erection was placed on adjoining land.

A right of light cannot be acquired in respect of a blank wall without apertures, for the building has not had access of light through such a wall. Further, if the owner of a building makes alterations to the structure such as opening new windows, he cannot claim a right of light through the windows, because, by doing so, he would increase the burden upon the owner of adjoining land.

Cleansing and Scavenging Houses and Streets

The statutory powers and duties of Local Authorities differ in the metropolitan area from those outside the Metropolis.

In London every sanitary authority, i.e. the Borough Council, must make proper provision for the removal of house refuse at proper periods and must give proper notice of the times appointed

for such removal. Should the sanitary authority fail to remove such refuse at the appointed time, an occupier of a house can give notice in writing requiring such removal, whereupon the authority must within forty-eight hours (excluding Sundays and Bank Holidays) carry out the work. House refuse for this purpose means ashes, cinders, breeze, broken china, rubbish, night soil and filth, but does not mean the refuse of any trade manufacturer, or business or building materials.

If an owner or occupier asks a sanitary authority to remove trade refuse, the authority must do so, but they may make a reasonable charge for the removal. In the event of dispute as to whether refuse is trade refuse or not, either the occupier or the authority can apply to a petty sessional court for a decision.

All house refuse collected by the authority belongs to the authority.

Every sanitary authority in London must keep the streets which have been taken over and are repairable by the inhabitants at large, so far as is reasonably practicable, properly swept and cleansed, and must remove all street refuse, that is, all dust, dirt, rubbish, mud, road scrapings, filth, ice and snow. The authority is liable to a fine not exceeding £20 if it fails in this duty.

Outside of London a local authority must, if so required by the Minister of Health, and if not so required, may undertake the removal of house refuse and cleansing of cesspools, etc. The authority may undertake to do so either for part of its district or for the whole district. The authority may require the owner or occupier of premises to provide dustbins of a size and construction as shall be approved by the authority, or may themselves provide and maintain such dustbins at a charge not exceeding 2s. 6d. per annum for each dustbin. The authority may make bye-laws as to the matter which may be placed in dustbins.

If an authority has undertaken to remove house refuse, etc., and without reasonable excuse fails to do so after having received notice from an owner or occupier requesting such removal, the owner or occupier is entitled to recover as a civil debt from the authority five shillings per day (after the first seven days) during which the authority is in default. What is a reasonable excuse is a question of fact in each case.

The local authority may agree to remove any kind of trade refuse, and is entitled to make a reasonable charge for so doing.

A local authority may undertake the cleansing and watering of streets in any part or the whole of the district. The local authority must do so, if so required by the Minister of Health.

It is an offence for any person not employed by the local authority to sort over or disturb the contents of a dustbin which has been placed for collection.

Death of Owner

On the death of an owner of land, the land passes by law, in the first instance, to the personal representatives of the deceased, i.e. when the deceased has left a will, the executors of the will; when there is no will, the administrators of the estate.

The value of the property forms part of the value of the deceased's estate upon which estate duty is payable. If the value of the whole of the deceased's estate, including the value of any land, does not exceed £2,000, no estate duty is payable. In order to ascertain the value it may be necessary to employ a qualified valuer who will agree a valuation with the local District Valuer. In many cases, however, it is not necessary to employ a professional valuer as the executors can make their own valuation and agree it with the District Valuer.

The value for estate duty purpose is the market value at the date of the death of the owner, but owing to the enhanced prices of houses caused by the war an important concession has been made by the Crown, namely, if the deceased was the owner-occupier of a house and a near relative (say wife or child) who was living in the house before the death remains in the house afterwards, then the pre-war market value is accepted and no notice taken of the increase in value which would be obtained if the house could be sold with vacant possession.

It should be pointed out, however, that if the house is sold within a reasonable period of the date of death, then duty will be claimed on the amount of the price obtained. As has been said, the property firstly is vested in the personal representatives. The personal representatives should then see that it is

transferred to the person entitled either under the will or intestacy.

The fact that a house is given to a person by the will of the deceased does not of itself transfer the property to the beneficiary. The executors must formally transfer the property. Similarly in the case of an intestacy, the administrators must transfer the property to the person entitled to it. This transfer is carried out by a simple form known as an "Assent." If the property is registered at H.M. Land Registry, the Assent must be registered with that department.

SECTION II

THE HOUSE STRUCTURE

CHAPTER VI

BRICKWORK AND MASONRY

Most house walls are of brickwork or stonework. These are traditional wall types, and there is no sign yet that they are likely to be displaced by newer materials, though they are yielding a little ground to prefabricated types of construction and also to concrete.

Brickwork and masonry are "wet" types of wall construction, the walls being built up brick by brick or block by block, using mortar to hold the units together. In wet construction a considerable amount of water is put into the structure, and we must wait for this to dry out before we can safely occupy the house. This drying out period may be three, six, nine or even more months, depending on the weather.

Absorbency

As already mentioned, ordinary walls of solid bricks or blocks and mortar are absorbent. Except during prolonged spells of heavy rain, water does not penetrate right through a solid wall, provided that the materials and workmanship are good. For exposed positions the cavity wall (see p. 12) is advisable. But in both solid and cavity walls we must prevent damp rising from the ground by building a course of damp-proof material a few inches above ground level.

The damp-proof course

The materials most commonly used for this purpose are:

(*a*) *Natural slates in cement mortar.* There should be two courses of slates laid to break joint. The mortar should consist

of one part cement to one part clean sand. Neat cement should not be used as it tends to develop shrinkage cracks.

(*b*) *Non-absorbent "engineering" bricks in cement mortar.* Two courses should be used. Suitable bricks are the blue Staffordshire and the Accrington engineering—both very dense and practically non-absorbent.

(*c*) *Sheet asphalt and bituminous felt.* This material is like good quality roofing felt. It is flexible and is supplied in rolls of wall widths. There is no strong adherence between the

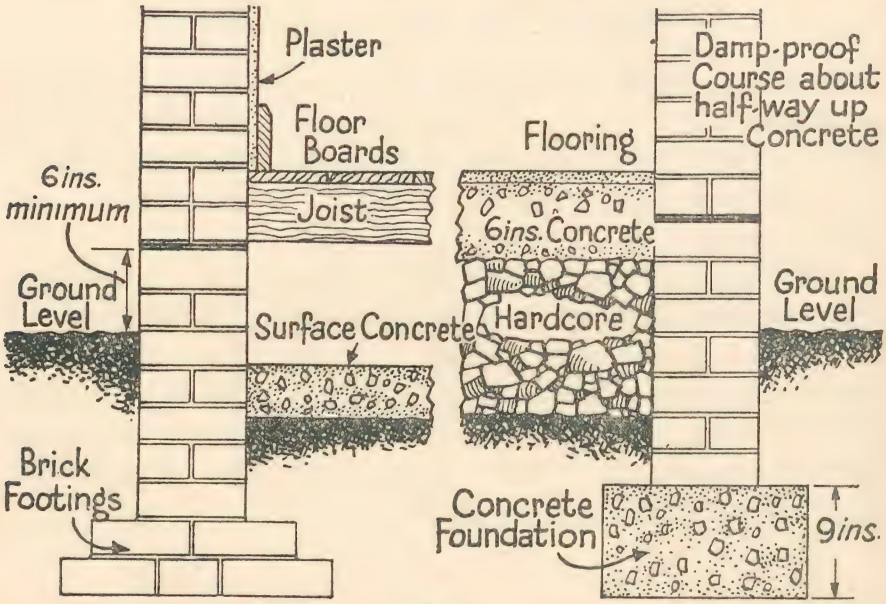


FIG. 1

Section showing 9-in. solid brick wall with timber ground floor

Section showing 9-in. solid brick wall with concrete ground floor

bituminous material and the mortar, but usually this is of no consequence.

(*d*) *Sheet lead and sheet copper.* These materials are also flexible and supplied in rolls. They are good and durable, but as they may be corroded by certain salts in the mortar they should be protected with bitumen. Some proprietary damp-proof courses consist of lead sandwiched between bitumen.

(*e*) *Mastic asphalt.* This is heated and worked on to the wall bed on the site. It tends to squeeze out under load and is not ideal for use just above ground level where the dead weight of the wall is considerable.

The building by-laws stipulate that the damp-proof course

must be at least 6 in. above ground level (see Fig. 1), though with an uneven ground line it is in practice often less. If it is too near the ground rain may splash the wall above the damp-proof course, and if it is buried beneath the ground the wall will obviously absorb moisture from the soil.

The damp-proof course must be under the floor joists, so that the floor timbers are kept dry. With solid concrete floors it should be an inch or two above the bottom of the concrete as in Fig. 1. In some positions the damp-proof course has to be

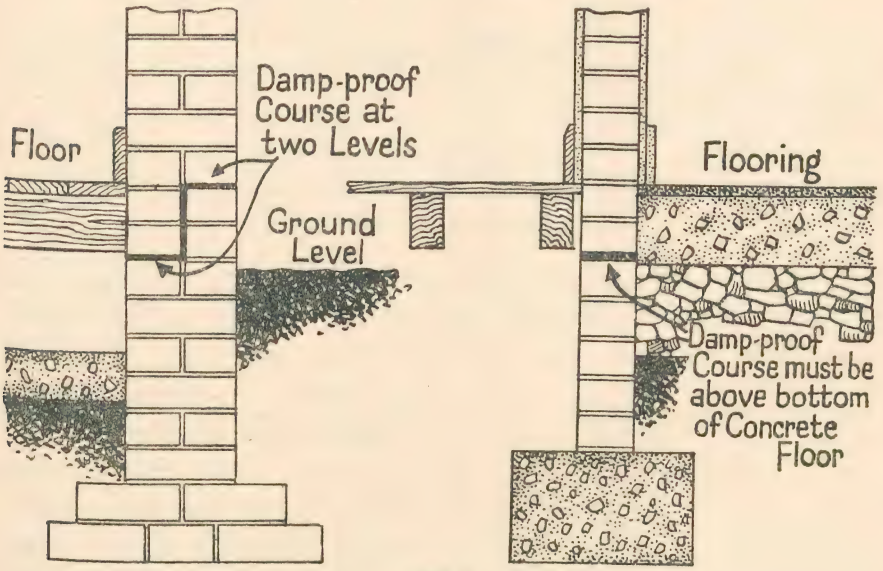


FIG. 2

If the floor is very close to ground level the damp-proof course must be stepped in two levels

A 4½-in. partition wall with timber floor on left side and solid floor on right

laid in two levels, so that a portion of it is vertical, as in Fig. 2. But it must provide a continuous barrier against rising damp.

Faulty damp-proof courses

If damp is rising up the wall, and damp patches show inside just above the floor, examine the damp-proof course. It may be too near the ground or even beneath the surface. In an old wall there may be cracks through settlement. It will not be sufficient to fill the cracks with mortar. A few bricks must be cut out and a new portion of damp-proof course material inserted to bond with the old.

If there is no damp-proof course—and in houses more than a hundred years old they are rare—it may be necessary to put one

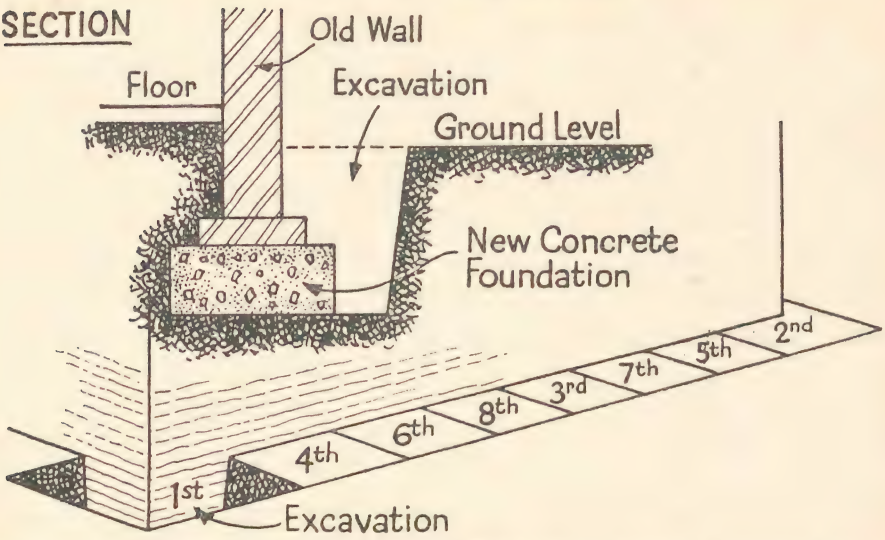


FIG. 3. UNDERPINNING AN OLD WALL TO ADD NEW CONCRETE FOUNDATION
This is done in sections in the sequence shown

in, though easier methods are described on p. 24. Inserting a damp-proof course is laborious, though not beyond the skill of a handyman with some experience of brickwork. Cut out the walling in short lengths —about two or three brick lengths at a time—and lay two courses of slates in cement mortar. When completed point the edge. But examine the floor and ground levels before you set to work to make sure that you can place your damp-proof course under the floor joists and above the ground. If the floor is low you may have to step-up the damp-proof course in the middle of the wall, as in Fig. 2.

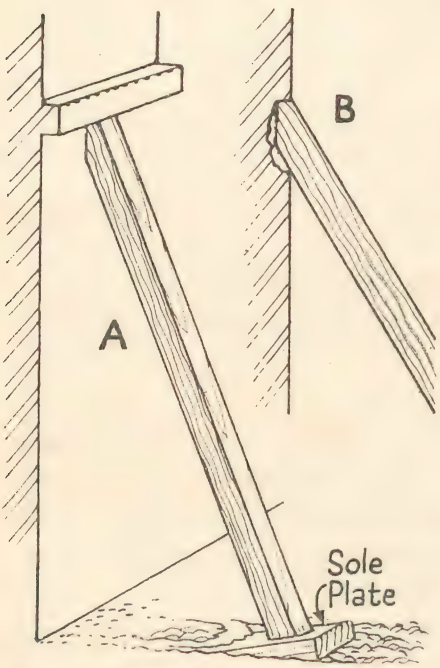


FIG. 4. SIMPLE SHORES TO SUPPORT DANGEROUS WALLS
A. Shore fixed against sill or other projection
B. Bricks cut out to enable shore to be fixed

Foundations and settlement

If there are bulges in the walls, or they are out of plumb, or if they have cracked badly,

unequal settlement of the foundations is indicated. If the defects are not extensive and do not continue there is nothing to worry about. Just point up the cracks. If the movement continues (you can check this by taking measurements every week) they must be arrested or serious trouble will ensue.

A wall which is out of plumb or bulging in the upper parts may be sustaining a sideways thrust from roof timbers. We will deal with this trouble later. If, however, the wall movement is clearly due to unequal settlement of the foundations the

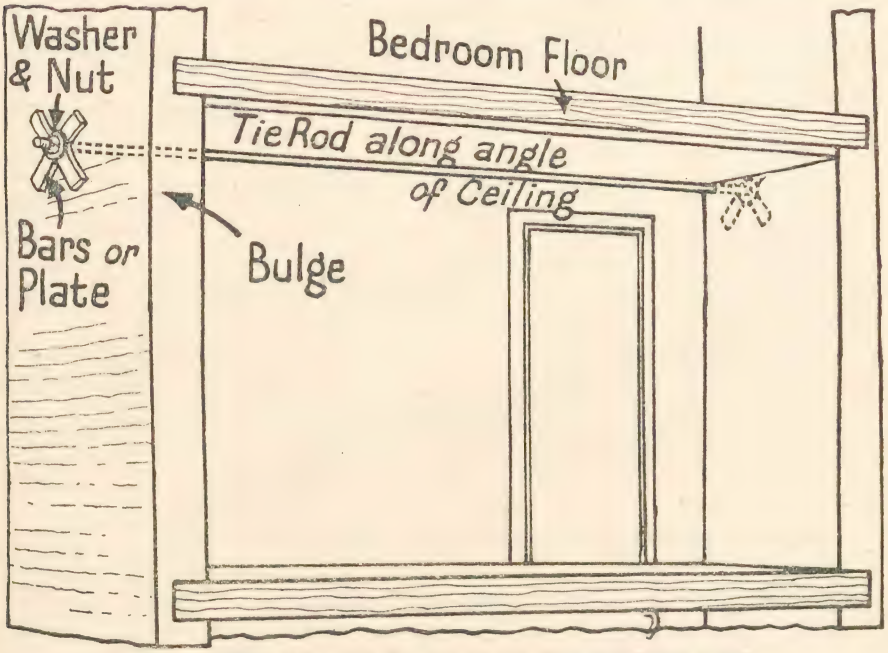


FIG. 5. STEEL TIE RODS TO TIE IN AN OLD BULGING WALL

remedy is to underpin the foundations with new material—wider brick footings or concrete.

Underpinning foundations is another laborious job, and it, too, is done in short lengths. But you must not start at one end of the wall and then continue along it. Arrange the work according to the plan in Fig. 3. The lengths should not exceed 2 ft. at a time. Pack the new foundation right up to the underside of the old—using slates or tiles. The idea of the sequence plan is that each section must set hard before the adjoining one is commenced, and also to ensure even support along the whole wall length.

If the wall is in a dangerous condition shore it with a few stout props, cutting out a few bricks to provide a "needling" point for the head of each shore, as in Fig. 4.

A badly bulging wall—from whatever cause—should be tied in by running steel rods right through the house. In some cases these can be conveniently hidden in the bedroom floors, in others they can be run alongside cross walls. You must get a blacksmith to work a thread on each end and provide a strong plate or two bars forming a cross, with nuts, so that the stress at each end is distributed over about 1 sq. ft. of wall, as in Fig. 5. Tighten the nuts and the bulge is then held securely. If you do this in cold weather tighten the nuts again in hot weather, as the rod will then have expanded and the tie become slack.

There is another method of dealing with a bulging wall.

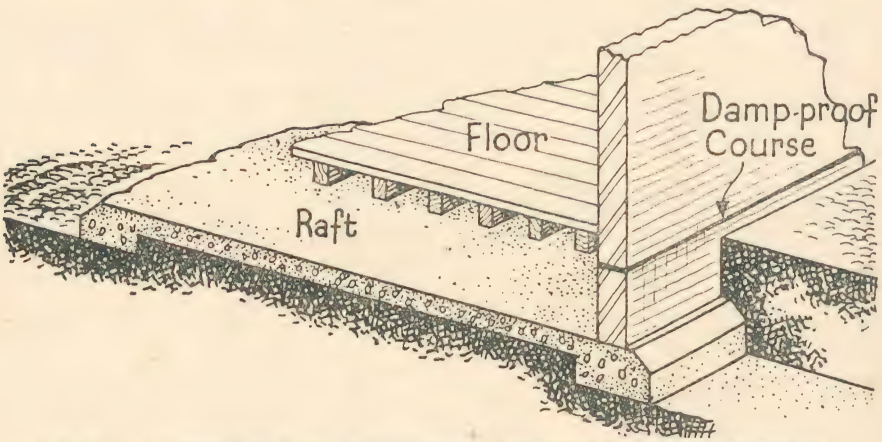


FIG. 6. A CONCRETE RAFT FOUNDATION SUITABLE FOR WEAK GROUND

This is by building a solid buttress against it. It is not a difficult job, but is only convenient if the bulge is not too high up. You must bond every three or four courses of the buttress into the wall, otherwise the wall will slide on the buttress, and a good foundation is needed to prevent the buttress settling under the load.

Pointing

To prevent decay and dampness the exterior face of the walls must be kept in good condition, and this means chiefly maintaining the pointing. Pointing looks a simple job but there are few snags, and a lot of practice is needed to make a good neat job.

Some handymen point decayed joints without any preparatory work and are then surprised to find that the pointing drops out after a few months. A firm key must be provided for the new

mortar, and this is done by raking out the joints to a depth of at least ½ in., and preferably more. Then brush away all soft or loose mortar and dust. And just before applying the new mortar wet the joints, otherwise the dry wall will absorb the water in the mortar before it sets. The mixing of mortars will be described later (see p. 110), but it is a mistake to make a pointing mortar too strong—especially if the bricks or stones are rather soft. The strength of the mortar should not be much greater than the strength of the bricks or stone blocks.

Pointing mortar should be firmly pressed into the open joint. Clean off the work as you go along. If mortar is allowed to set on the bricks or stones it will look very unsightly. There are various ways of finishing joints, but the weathered joint (Fig. 7) is the best as it throws off the rain. To make a neat finish cut off the lower edge of the mortar with the edge of the trowel, using a straightedge to rule the line.

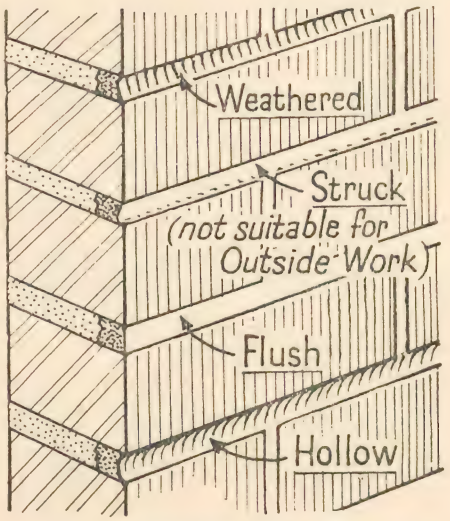


FIG. 7. POINTING AND JOINTING

Very old brickwork looks best with a flush joint, and this should not be ruled off as it looks better with an irregular edge.

Projections

Moulded and other projecting courses may cause trouble by allowing water to collect on the top surface. With decay the surface becomes very absorbent and a damp wall may result.

This top surface of a projecting course should be "weathered" —that is, it should slope outward to throw off the rainwater. You can form a weathering in cement mortar, but in time it will open a fine crack against the wall. A metal flashing makes a better job (see Fig. 8).

Flashings

The purpose of a flashing is to make a watertight junction between one surface and another—as between a roof and a

chimney. In many old houses there are no metal flashings—the junction is made tight with mortar and usually there are projecting courses over it to provide some shelter.

A cornice or string course is quite easy to cover with a lead, zinc or copper flashing. Rake out a joint above the projection and tuck in the top edge of the flashing. Then wedge it with

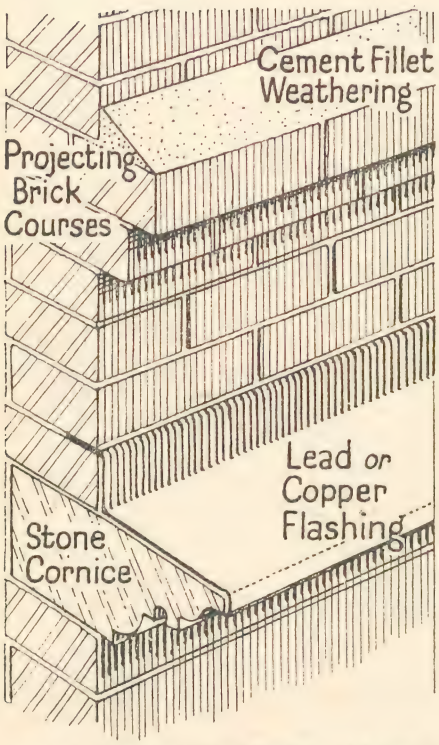


FIG. 8. PROJECTIONS FROM THE WALL SHOULD BE "WEATHERED" ON TOP TO THROW OFF RAINWATER

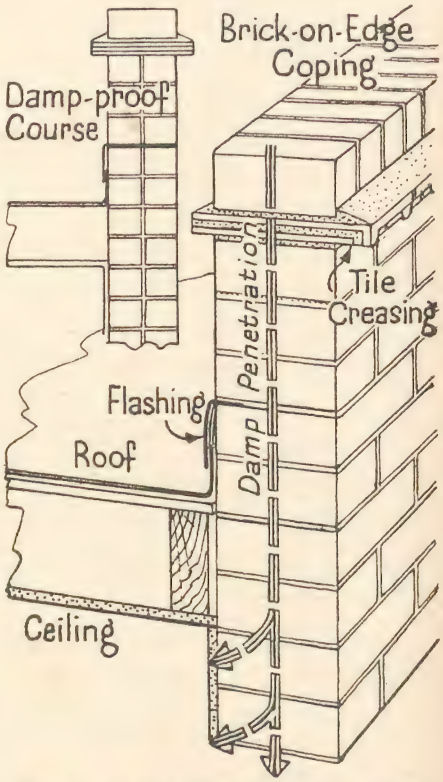


FIG. 9. A ROOF PARAPET SHOULD HAVE A DAMP-PROOF COURSE FIXED ON THE LEVEL OF THE FLASHING TO PREVENT RAIN SOAKING DOWN THE WALL

lead or copper wedges and finally point the joint. The lower edge of the metal should be neatly turned over the front of the projection.

Parapets and copings

Some roofs are concealed behind parapet walls, as in Fig. 9. A parapet is exposed to the weather on all sides and the coping and pointing should be carefully maintained, not forgetting the pointing at the back which is not seen from the ground. It is necessary to have a damp-proof course just above the roof to

prevent water soaking down the wall. In old houses there may not be such a damp-proof course, and if damp appears in the bedrooms high up on the wall or on the ceiling this is probably the cause. To insert a damp-proof course here, take the parapet down to the course where the roof flashing is tucked into the walling. Lay two courses of slates in cement, as already described, and rebuild the parapet.

If the coping is badly decayed it is advisable to remove it and replace with new pre-cast concrete coping units. These should overhang the wall on each side and have a throating under the overhang to allow water to drip off. A coping can be formed in brick-on-edge with two courses of roofing tiles called tile "creasing" under, as in Fig. 9. The projection of the tiles should be weathered in cement mortar.

Crumbling brickwork

Faulty bricks flake and crumble in time, and this decay is hastened by frost—the water expanding as it freezes and forcing the loose material off. The faulty bricks can be chipped away and the gap made good with cement mortar, but this is an unsightly treatment. It is better to cut out the decayed bricks and replace with new ones, taking care to obtain bricks which are about the same size as the old. If old bricks to tone with the existing work can be obtained, so much the better. If the work is in strong cement mortar it will be very difficult to completely remove the defective bricks, but if each brick is cut out to a depth of $2\frac{1}{4}$ in. a bat can then be cut to replace it. Brush and wash out the cavity before fitting a new brick.

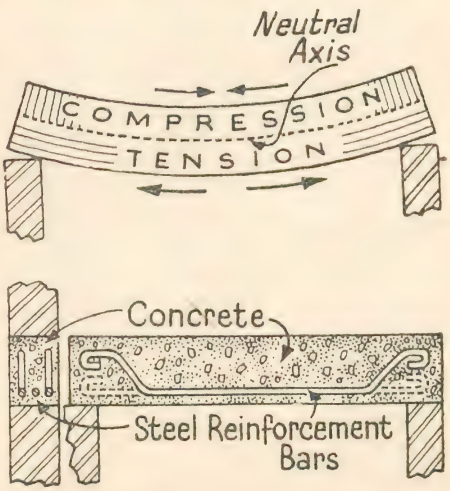


FIG. 10. REINFORCED CONCRETE IS OFTEN USED FOR BEAMS AND UPPER FLOORS

These diagrams show how the steel reinforcement takes the tensile stress or "pull" due to bending

Bonds

The chief bonds are: stretcher, header, Flemish, English, garden wall.

Stretcher bond should only be used for half-brick (4½ in.) walls, though in old cottages you may find it used in the outer 9-in. walls, in which it obviously has no transverse bond and is therefore weak. Header bond should be used on curves only.

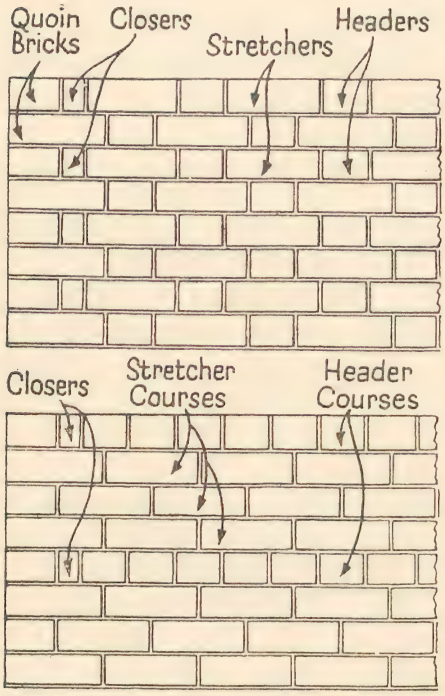


FIG. 11

Top: **Flemish Bond**
Bottom: **Garden Wall or "Three-and-one bond"**

Flemish and English bonds are the best. Flemish bond consists of alternate stretchers and headers in each course, and as in all brickwork the courses are laid to break joint. English bond consists of a course of headers to a course of stretchers.

Garden wall bonds are various, but the most common (also known as "Three and One" bond) consists of three courses of stretchers to one of headers. This is quite a strong bond and is often used in house construction, even of the best class, because it is economical in facing bricks.

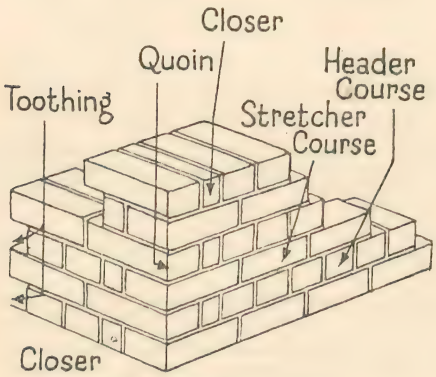


FIG. 12. ENGLISH BOND

In repair work the bond should be preserved—a header being replaced by a header and a stretcher by a stretcher. If the walls are bulging or cracking examine the bond—the defects may be due to poor bond combined with poor quality mortar.

Masonry

Many of the descriptions of brick walling given in the foregoing apply to stone masonry. Damp-proof courses are just as

necessary, bonding just as important. But there are, of course, important differences.

House walls in stone are of two main types: Rubble walling, which includes all kinds from rough uncoursed stones to squared and regular coursed work. And ashlar faced walling, the facing and beds of which are squared and brought to smooth surfaces. Ashlar is costly work and very rarely used in modern houses.

In rubble walls the larger stones are used on the outer faces and the middle is filled up with smaller stones. Large stones of full wall thickness are placed at intervals of about 1 sq. yd. to give transverse bond. In poor quality rubble walls these bond stones are omitted, or are too few, and the work is then weak. If the mortar also is weak the facing may bulge away from the rest of the wall.

For many years past it has been a common practice to build stone walls with brick backing, as the brickwork gives a better surface for plastering. Bond stones should pass through the brick backing so that brickwork and stonework are held together.

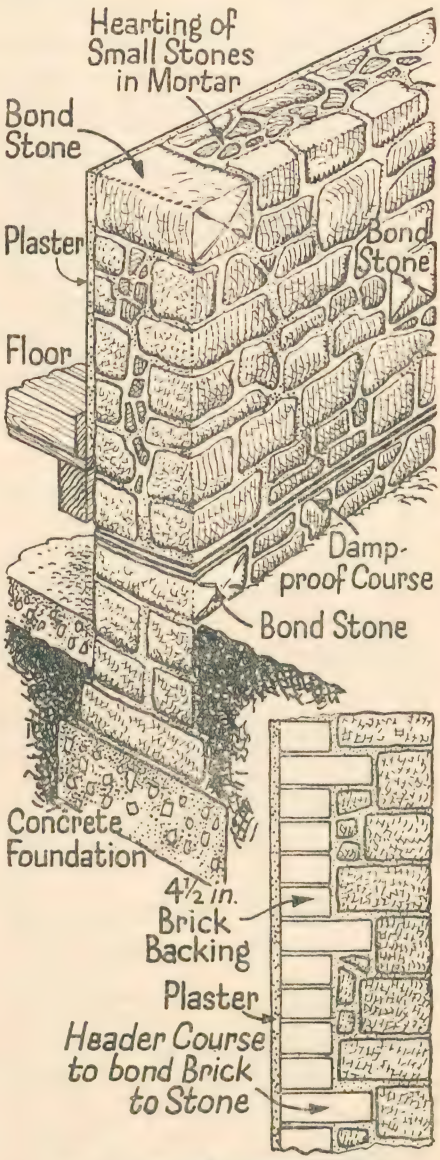


FIG. 13. STONE RUBBLE WALLS
In modern work they are brick backed as shown in the lower diagram

The rougher the rubble the thicker are the joints, and if the interior joints have not been properly filled with mortar, or if the jointing decays, the wall may admit damp. Another cause of dampness in stone walls is excessive softness of the stone. General decay of the walling may also admit damp.

Mortars for masonry should not be very strong. It is advisable to use a lime-cement mortar (see p. 110) which is quite strong enough. If the stone is rather soft a strong cement mortar may cause it to flake, owing to salts present in the cement crystallizing in the face of the stone.

Some stones, notably sandstones, are soft and weather badly, while atmospheric impurities cause decay. In towns periodic

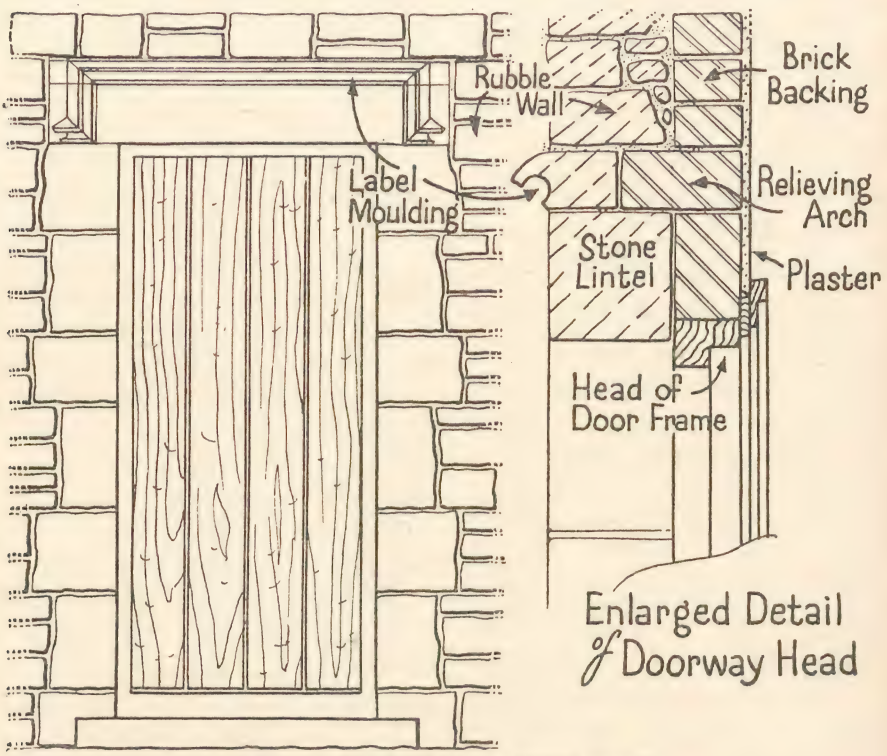


FIG. 14. DOORWAY IN A STONE WALL
The label or hood moulding prevents rainwater running down to the door head

steam cleaning is the best way to preserve stone. Proprietary preservatives are of doubtful value.

Decayed stones may be hacked to form a key for a lime-cement rendering to make good the surface. Large cornices which have decayed may be cut off flush with the wall, or the cornice may be restored to its original profile by working the mouldings in a lime-cement mix. The old stone surface should be cut away until a firm surface is provided and this should be punched deeply to provide a key. On large cornices it is better to fix expanded metal lathing attached to steel rods. This provides both key and reinforcement for the rendering.

Generally, the natural strata of stone should be at right angles to the axis of pressure. Ordinary walling blocks should there-

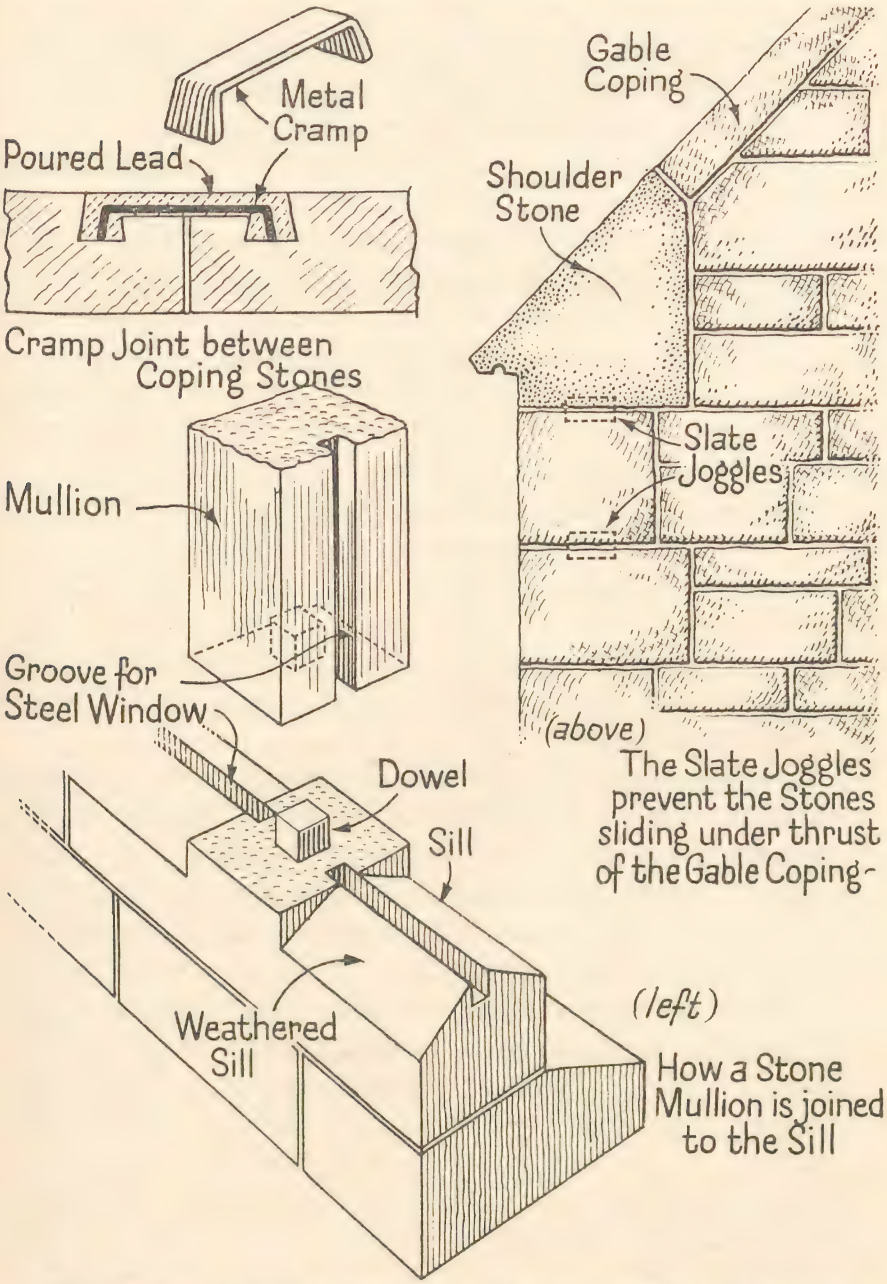


FIG. 15. SPECIAL JOINTS IN MASONRY TO PREVENT MOVEMENT OF STONES

fore be laid with the strata lines horizontal. Arch stones should have the strata lines at right angles to the thrust. Stone mullioned windows should have the mullions cut from very deep

beds so that the strata can be horizontal. If strata lines are not at right angles to the axis of pressure the stone tends to split and flake.

Old stone houses usually have many charming details, which are well worth careful maintenance. In repair work do not cut out more stone than is strictly necessary.

Artificial stone

There are two kinds, which are both made in a similar manner to concrete. Reconstructed stone is indistinguishable from the natural product and is often superior in strength and durability. Crushed natural stone is used as the aggregate.

Imitation stone is really a pre-cast concrete product incorporating coloured sands and pigments to give an approximate imitation of a natural stone.

In both types the surfaces may be treated by bush hammering and tooling to give any required texture.

Mortars

A mortar is a mixture of fine aggregate (usually sand) with a binding material (lime or cement). There are three kinds of mortar in common use:

(*a*) *Lime mortar*. The strength depends upon the hydraulic quality of the lime. Hydrated lime makes a very weak mortar. A strong hydraulic lime such as Blue Lias makes a fairly strong mortar. Lime mortars are not so durable as cement mortars.

(*b*) *Cement mortar*. A mixture of sand and Portland cement, with water. The strength depends on the amount of cement, but very strong mortars are not necessary in house walls, are not easy to spread and tend to craze owing to shrinkage. As free salts are present in Portland cement and work to the surface (producing the white deposit known as efflorescence) the stronger the mortar the greater the deposit of salts.

(*c*) *Lime-cement mortar*. The best for ordinary walling as it is of moderate strength, is durable, works easily off the trowel, has only slight shrinkage and no great tendency to efflorescence.

Lime mortars are not recommended—at least, not for the handyman's use. For steps, copings, damp-proof courses and other work where high strength and density are required use a

cement mortar. *One part Portland cement to three parts sand* makes a mortar of adequate strength, though for damp-proof courses the proportion of sand may be reduced to two parts.

Lime-cement mortars are recommended for ordinary walling.

A non-hydraulic lime should be used. The hydrated lime obtainable in bags is convenient as it is ready for use. A mix of *one part Portland cement, one part non-hydraulic lime, to four parts sand* makes a good mortar.

Mortars should be of similar strength and density to the bricks or other walling material used. A strong cement mortar applied as pointing to old soft brickwork or masonry may cause the brick or stone face to flake off as the salts are absorbed into the walling material where they exert pressure.

Mix the dry ingredients together on a clean wooden platform and then add water from a watering can fitted with a rose. Mix thoroughly with just enough water to make the mortar workable. Too much water will weaken the mortar.

Cement mortar should be used within half an hour of wet mixing. Lime-cement mortar within three hours of mixing. Lime-cement mortar can be retempered by adding water within about nine hours, though this will result in some weakening.

Lay mortar on the walling bed with the trowel and spread. Take some mortar on the trowel and spread it on the end of the brick and then press the brick firmly on to the mortar bed, giving it a tap with the trowel handle if necessary to level it. Bricks should be wetted shortly before laying.

A line should be stretched between pins inserted in the wall joints at either end of the wall to give a level line to which the bricks or stones should be laid. The plumb rule should be frequently used to test for uprightness. Neat bricklaying can only be done after considerable experience.

CHAPTER VII

CONCRETE

Simple concrete work is within the ability of the average handyman, but it is necessary to understand the material and how to mix and place it if costly failures are to be avoided.

Types of concrete

There are two chief types: the rather dense heavy concretes and the lightweight concretes.

The dense concretes should be used wherever strength, weathertightness and hard wearing qualities are needed.

The lightweight concretes are absorbent and should only be used where they are protected from moisture. They have three good points: they do not encourage condensation, are good insulators and are light in weight. They vary in strength from weak to moderately strong according to the ingredients and methods of mixing.

Concrete houses

In concrete houses the material is used in three forms: *in situ* concrete which is poured in a plastic condition into wall formwork or shuttering, and is spread over the ground to form a base for solid ground floors. In upper floors and flat roofs it is poured on to shuttering.

In the two other forms it is pre-cast and bought "ready-made" in units of various types and sizes. In one form it is used to make solid or hollow blocks for walling and floors, and in the other is made into units for prefabricated construction (see p. 43).

Ingredients.

Dense concretes for outside and hard-wearing uses consist of a suitable cement, a coarse aggregate which may be granite or stone chippings or broken bricks, and a fine aggregate which is usually clean sand.

Portland cement is the cement in common use, but there are also rapid-hardening and aluminous cements of which we will say more later. Portland cement readily absorbs moisture, and this soon spoils it. Good fresh cement should feel slightly warm if the arm is plunged into it, and it should be powdery throughout without any lumps. If you have to store cement keep it in a dry place and stand the bags on a wood platform.

White and coloured Portland cements are made which are useful for work in which the natural grey colour would be objectionable. But these cements are more costly than the ordinary type, and it is usual to incorporate them only in a facing mixing about 1 in. thick.

The coarse aggregate must be clean, of suitable grading or size and of sufficient strength. Coarse gravel, granite chippings and crushed hard stone are the strongest, but broken brick is quite suitable for most work provided the bricks are clean and of a hard dense nature. Each piece should not exceed $\frac{3}{4}$ in. for such work as walling and floors, and where steel reinforcement is used or the concrete is thin it should not exceed $\frac{1}{4}$ in. For rough filling under floors the pieces may be coarser—up to 2 in.

The fine aggregate (sand) must be clean and well graded. By grading is meant that the particles should range from fine to coarse. Anything up to $\frac{1}{8}$ in. counts as fine aggregate. If the sand is clean it will not discolour the hand if you rub it, except that some finer grains will adhere to the skin.

If your subsoil is sand, it may be suitable for concrete if you take it from a depth of not less than 4 ft. The surface sand is contaminated with vegetable soil which is washed down. But sand is so cheap and obtainable in any district that it is not worth digging it out.

Proportions

To obtain maximum density all the voids must be filled. This means that the coarse and fine aggregates must be correctly graded from fine to large particles and the ingredients must be used in correct proportions. Then the voids between the larger pieces of aggregate will be filled with smaller pieces, each surrounded by and cemented to the others with cement. In practice it is not easy to ensure that no voids are left, and for most purposes a small proportion of voids do not matter.

A good mix of moderate strength, suitable for walls, steps and general outside use, can be made of the following proportions: 112 lb. Portland cement, $2\frac{1}{2}$–$3\frac{1}{4}$ cub. ft. sand (the lesser amount if it is dry and the greater if it is wet), 5 cub. ft. coarse aggregate. The coarse aggregate to be strong material such as gravel, pieces not exceeding $\frac{3}{4}$ in.

To measure the aggregates make a bottomless box of $2\frac{1}{2}$ cub. ft. capacity. If the sand is dry use one box of sand to 2 boxes of coarse aggregate and add 112 lb. Portland cement (cement is sold in 112-lb. paper bags). If the sand is moist and therefore swollen you must allow rather more than a boxful.

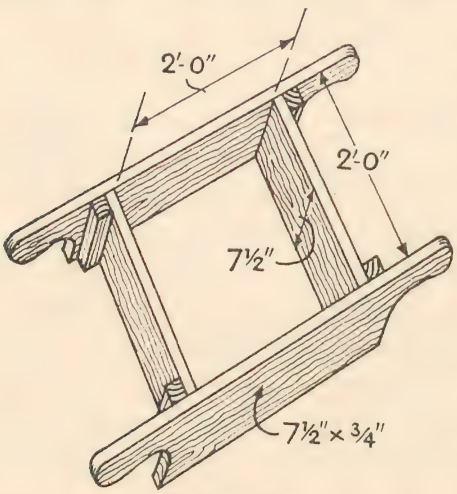


FIG. 1. A BOTTOMLESS "BOX" FOR MEASURING THE DRY SAND, CHIPPINGS AND CEMENT
The capacity is 2¼ cubic feet

A stronger concrete for pre-cast work and thin sections can be made by doubling the amount of cement to the same amount of sand and coarse aggregate given above. For such work the coarse aggregate should consist of gravel or very dense broken stone not exceeding $\frac{1}{2}$ in.

A weak concrete suitable for filling under solid floors (with a stronger layer on top) or for foundations to bear moderate loads can be made by using the above amounts of sand and coarse aggregate with half the amount of cement.

Mixing

As water is cheap most handymen use too much of it in making concrete. The quantity should be just sufficient to make a stiff but thoroughly wet mix. Too much water is as bad as insufficient—both result in weakness. The right amount is from 15 to 20 per cent. by volume of the solid materials, though if the coarse aggregate is absorbent, such as broken brick, the amount of water may be increased to 25 per cent.

Mix on a clean wooden platform about 6 ft. square. Mix the sand and coarse aggregate first, then add the cement and

turn over the three ingredients until they are thoroughly intermingled and the mix is of even colour.

Use a water can fitted with a rose to add the water. One person should do this while another mixes with the spade. The wet mixing is very important and should be continued until the whole is evenly moist and workable.

Placing

The wet concrete should be placed in position without delay. What is called the initial set takes place 30 minutes after adding the water, so the concrete must be placed within that period. It must not be disturbed after the initial set or it will be greatly weakened.

The concrete should be tamped into position with a piece of timber or other implement. Tamping should be just enough to consolidate it and drive out air bubbles. In reinforced concrete care must be taken to tamp it tightly into the small spaces around the reinforcement. For thin sections rather more water than normal will be required in the mix so that the concrete can be tamped into position.

Shuttering or formwork

For concrete work which does not rest on the ground, temporary shuttering is required to hold it in place until it sets. For walls, upper floors and general construction the construction of the shuttering is elaborate and calls for skill which is beyond the average handiman. But he may safely undertake such work as garden walls and steps.

Even in the simplest work the shuttering must be quite firm, and it must be remembered that wet concrete exerts considerable pressure—being more like a fluid than a solid.

Wood boards, plywood or hardboard sheeting can be used for shuttering, supporting it with posts, beams, struts, etc., as necessary. The interior face must be treated with oil or whitewash to prevent adherence of the concrete.

Concreting must not be carried out in very cold or frosty weather. Frost will destroy the strength of wet concrete.

The shuttering must not be removed until the concrete has attained sufficient strength. For most work, including wall sides and flat slabs up to 3 ft. span, the shuttering should remain

for at least 4 days. And for certain work such as beam bottoms for 16 days.

Walls should be concreted in long layers about 12 in. deep and should not "rise" at a rapid rate or the pressure on the shuttering may cause it to collapse.

Laying floors and paths

Solid floors should be at least 4 in. thick on strong ground and 6 in. on weak ground. Paths should be 3 in. thick and drives

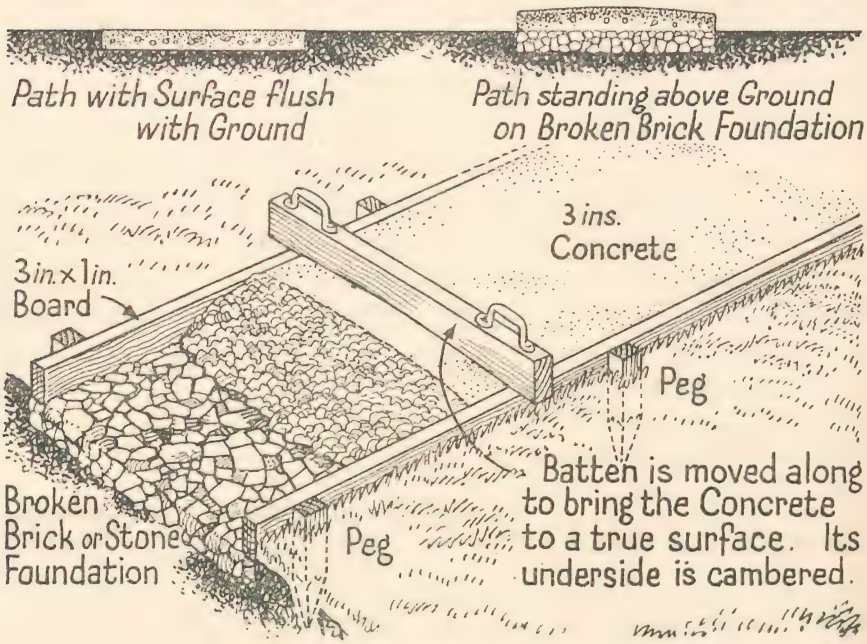

Path with Surface flush with Ground
Path standing above Ground on Broken Brick Foundation
3 ins. Concrete
3 in. x 1 in. Board
Peg
Batten is moved along to bring the Concrete to a true surface. Its underside is cambered.
Broken Brick or Stone Foundation
Peg

FIG. 2. CONCRETE PATHS
The batten or screed is used to smooth the surface

to take ordinary car traffic should be 6 in. thick. If the ground is weak the drives should be reinforced with expanded metal.

Thick boards should be placed at the edges of paths and supported with pegs driven into the ground. To ensure a level surface the top edges of the boards should be levelled, and as the concrete is placed and spread a straight-edge should be passed over the board edges, as in Fig. 2. This will smooth the surface as well as level it.

Surface finishes

There is a wide variety of surface finishes for concrete—some decorative, some hard-wearing and some damp-proof.

Pavings and paths

For solid floors inside the house an additional paving is laid on top of the concrete (see p. 123). For shed, garage and outbuildings the concrete should be lightly trowelled with a steel or wood float. It is a common mistake to "iron" the surface with a steel trowel until it is not only smooth but polished. This draws neat cement to the surface, and neat cement shrinks and dusts up under wear, so the neat polish quickly disappears.

To make a hard-wearing or a damp-proof surface treat with silicate of soda (waterglass). Any builders' merchant will supply a suitable brand. It has to be diluted and should be applied with a mop in two coats. This sets hard in the surface pores. There are also proprietary hardeners and damp-proofers for concrete.

If you want absolutely watertight work (as for a garden pond, for example) it is advisable to incorporate a proprietary waterproofer in the mix, or the set concrete can be rendered with a waterproofed mortar.

Walls can be given an interesting texture by tooling. It is better to do this while the concrete is still "green" (before it attains maximum hardness). A claw chisel or a bush hammer can be used. If the concrete is still rather soft it can be brushed with a wire brush to reveal the aggregate.

White and coloured cement renderings make good decorative finishes, though they are costly.

Lightweight concrete

As already mentioned, these concretes are made by using lightweight aggregates, and there is another type called "no-fines" concrete, which is made without using sand and thus contains voids.

The lightweight aggregates include pumice, breeze and foamed slag. Breeze may cause trouble, as it often contains partially burnt coal which is liable to swell. Partition blocks are made of these materials. They are light but should not be used to bear loads.

A dense concrete encourages condensation, so a lightweight concrete should be used as an inside lining. This will also improve the thermal insulation. Lightweight concrete blocks

are cheap, and it is certainly not worth while making a special mix and erecting shuttering when these blocks can be used.

Concrete blocks

Both solid and hollow concrete blocks are made to a standard length of 17⅝ in., standard height 8⅝ in., with thicknesses for hollow blocks of 4, 4¼ and 8¾ in., and for solid blocks 3, 4 and 4¼ in.

If you wish to build a garage or shed the 8¾-in. hollow blocks are economical, fairly light and strong, and make a durable job.

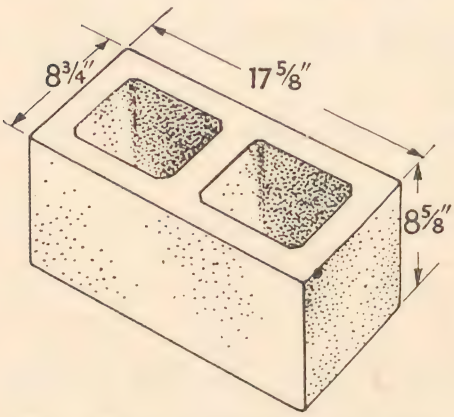


FIG. 3. STANDARD HOLLOW CONCRETE BLOCK
A block 4 in. thick is also made

Rapid-hardening cement

This is similar to normal Portland cement except that it is very finely ground and, in consequence, reaches 75 per cent. of full strength in 3 days instead of the 7 days required with normal cement. This is valuable when using shuttering, as the forms can be removed and re-used in about half the time necessary with normal cement.

Aluminous cement

This cement is ultra rapid hardening, though slow setting. The initial set takes place in from 1 to 3 hours (compared with 30 minutes for normal Portland cement), but the final set takes place within 2 hours. The slow initial set is valuable as it gives plenty of time to use the concrete or mortar, while the rapid final set enables the material to be brought into use within a few hours. Wall shuttering can be removed in 6 hours. Floors can be loaded in 24 hours. Aluminous cement costs more than twice as much as normal Portland cement, but there are considerable advantages in use. It is also stronger than Portland cement.

CHAPTER VIII

FLOORS

In houses floors are of two kinds. Most of them are wood floors consisting of timber joists spaced at about 15-in. centres with a flooring of planed boards, usually grooved and tongued, about 1 in. thick. The other kind is the solid floor, which in old houses consists of stone flags laid on levelled earth or ashes, but in modern houses is a slab of cement concrete over the ground or ballast filling with a flooring of granolithic concrete, quarry or other tiles, terrazzo or a composition flooring, rubber or linoleum cemented down.

You sometimes find solid floors upstairs. These are of reinforced concrete, though in most cases they consist of pre-cast reinforced units with a surfacing of concrete. Such floors may be found in houses built during and just after the Second World War, when the pre-cast units were more readily obtainable than timber.

Timber ground floors

In most houses these floors consist of 4-in. by 2-in. joists resting at the ends on pocket bearings in the outer walls and intermediately on sleeper walls under the floor, with a span between supports of about 5 ft. As ventilation is essential to prevent dry rot, the sleeper walls are either honeycombed or have air bricks which allow through ventilation from the air bricks in the outer walls.

Dampness must also be avoided and the timber joists must have damp-proof courses underneath, while the surface of the ground under the floor is sealed off with a layer of cement concrete from 3 in. to 6 in. thick. This concrete may be omitted where the soil is readily drained by natural means—as a deep subsoil of sandy gravel, for example. But in that case there should be a layer of lime riddlings to sterilize the surface. It should be explained that the top vegetable soil is always removed from the site before building commences.

Thus, the space under timber ground floors should be dry and well ventilated. The space is usually not less than 12 in. deep, and may be much more on sloping ground.

Timber floors will remain sound indefinitely if the sub-floor conditions are suitable, but the boarding shrinks and wears—especially deal boarding. Shrinkage is greatest in the width so that the joints open as much as $\frac{1}{8}$ in. or more. Wide gaps can

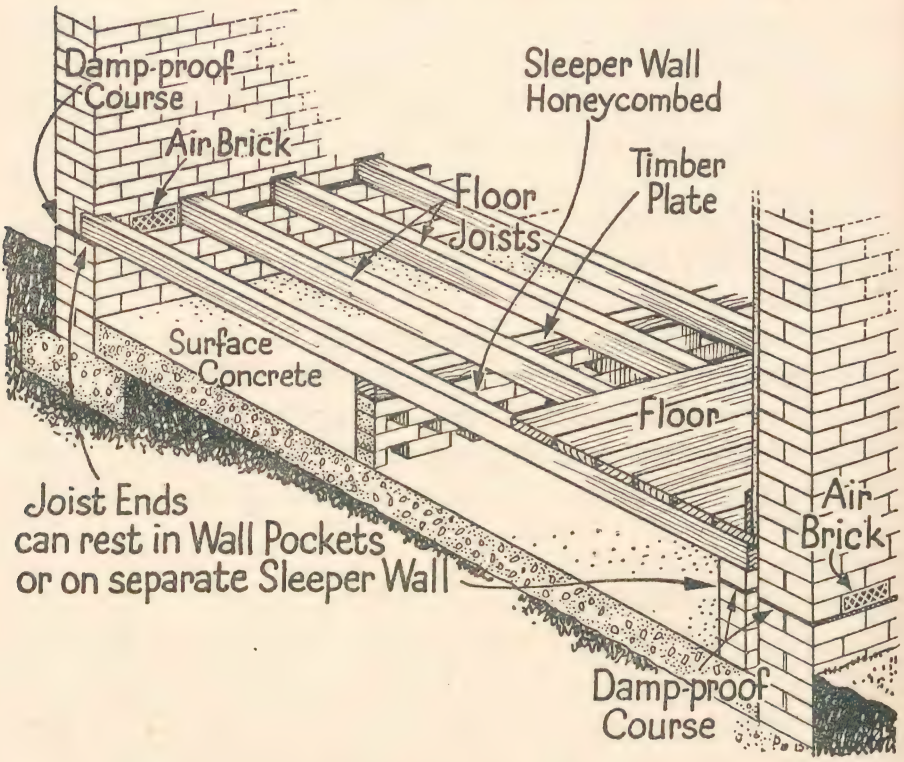


FIG. I. TIMBER GROUND FLOOR
Showing how joists are supported and the space under the floor is ventilated to prevent rot

be filled with narrow strips of wood, but it is tedious work. If thoroughly cleaned plastic wood can be applied, but at least part of this will work loose through shrinkage.

Floorboards warp across the width so that the edges stand up. These edges are not only unsightly but tend to cut through lino and carpets under wear. They should be planed down after carefully punching down the nail heads. It is surprising how planing or scraping (using a joiners' scraper) freshens up an old warped and badly marked floor.

A shrinkage gap opens between skirting and flooring. This

can be covered with a small moulding which should be nailed to the floor only, pressing it tightly against the skirting.

Timber upper floors

The joists are deeper than the usual ground floor joists as they span the full width between walls. The depth will be

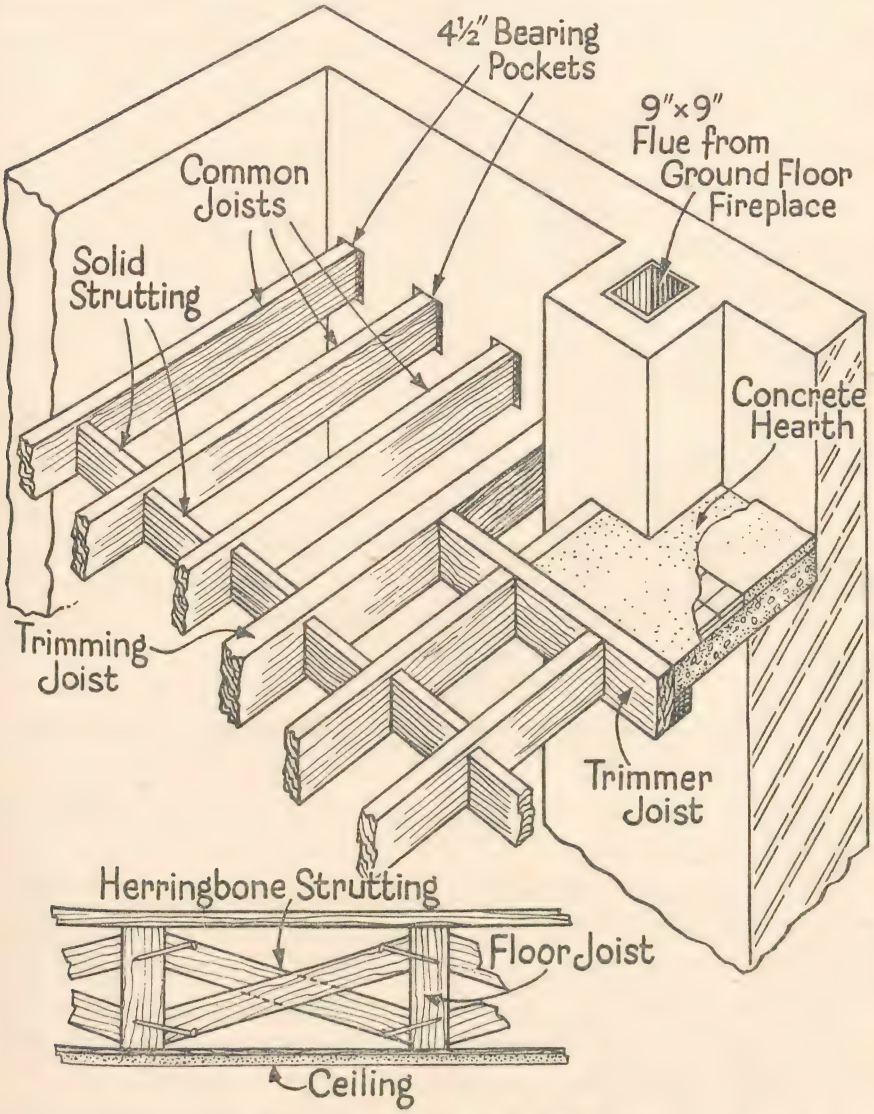


FIG. 2. TIMBER BEDROOM FLOOR
The joists are strutted along the middle of the floor

from 6 in. to 11 in. Floor joists should be at least 2 in. thick, and an approximate rule for determining the depth is to take ½ in. depth for every foot span plus 2 in. For example, a 10-ft.

span requires 7-in. by 2-in. joists. Joists should be spaced at 14-in. centres. The trimmer and trimming joists round hearths and staircases are a little thicker than ordinary joists.

To stiffen the upper floors the joists are strutted at intervals of about 5 ft. 6 in. Herringbone strutting consists of two cross-pieces skew nailed to the sides of the joists, and solid strutting consists of solid pieces about $\frac{1}{2}$ in. less in depth than the joists firmly wedged and skew nailed. A properly stiffened floor with

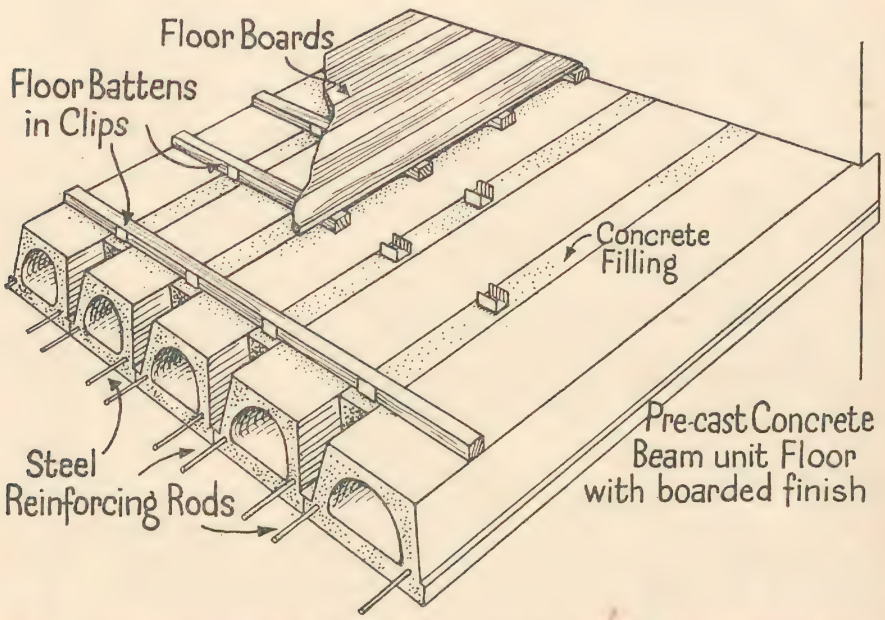


FIG. 3. SOME UPPER FLOORS AND FLAT ROOFS ARE OF PRE-CAST CONCRETE BEAM UNITS. FLOORBOARDS ARE NAILED TO BATTENS

joists of adequate size will not vibrate or "give" noticeably when you walk over it.

It is sometimes necessary to take up floorboards to fix new electric wiring or water pipes. A panel saw with a curved edge should be used for this purpose—inserting the saw in the floor-board joint and sawing through the tongue which holds it to the next board. If this is done both sides of a board for its full length the board can be removed.

If floorboards are rotten they should obviously be removed and replaced with new, but if the cause is general dry rot this treatment will not be enough. But this subject is discussed further on p. 196.

The best treatment for a worn and shabby wood floor is to

have it covered with plywood squares veneered with birch or oak. This is a fairly cheap job and there are firms specializing in such work. It adds little to the floor thickness, and a threshold can be fixed at the doorway if the plywood is not carried through to the next room.

If you have a parquet block floor which is in poor condition, any firm of flooring specialists will renovate it. Special plant is used for this work and an old floor can be made to look as good as new.

If you are having new water pipes or conduits fixed in an upper floor have them fixed parallel with the joists, if possible. If they have to be fixed across the joists and the joists have to be notched out, this, of course, weakens the joist by reducing its effective depth. The notching should not be more than 1 in. deep and should not be cut in the middle part of the span—the nearer the bearing points the lesser will be the weakening effect.

Solid floors

Kitchen, scullery, hall and garage floors are usually solid. They are constructed by first filling up to the required level with hard clean ballast (broken brick or stone) and then laying 6 in. of cement concrete which forms a solid base for the flooring. Red or russet quarry tiles are still the favourite pavings for kitchens and sculleries, with terrazzo or composition floorings for halls. Floor tiling is dealt with in detail in Vol. II, p. 329.

If you have a new quarry tile floor keep it in good condition by rubbing it over with a cloth soaked in linseed oil about once a week. Do not scrub tiles unless it is essential. Wash with ordinary soap and water and do not use abrasive cleansers or chemicals.

Terrazzo and mosaic floorings may develop cracks if laid in large areas without expansion joints. They wear well but need occasional renovation. A specialist firm will undertake the repolishing, using electric plant which is very effective.

Composition floorings are not so hard and cold as tiles and terrazzo, but the sub-floor must be dry as rising damp will cause trouble—the flooring cracking and swelling. Only reputable firms should be entrusted with composition flooring as it requires experience and skill to avoid defects.

Rubber and linoleum if cemented down either to concrete or

boarding are both excellent and will last for many years. This, too, is a job for the specialist firm. The base must remain quite dry to prevent buckling.

For garages a granolithic concrete paving is best. This is merely a fine concrete with granite chippings as aggregate. It is trowelled on to the ordinary concrete base, the granolithic being finished to about 1½-in. thickness.

Under hard wear granolithic and ordinary concretes are liable to dust up. They also readily absorb water. A proprietary

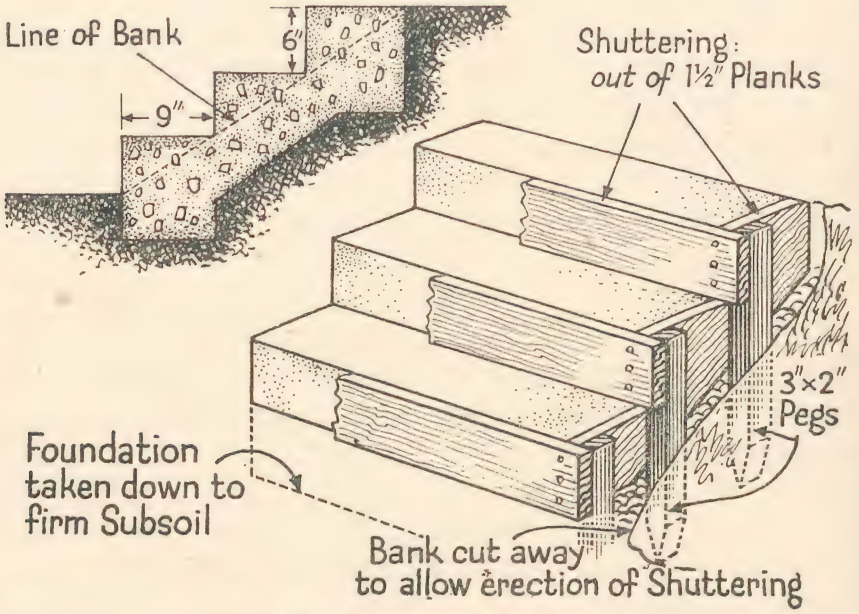


FIG. 4. CONCRETE STEPS

The temporary wood shuttering holds the concrete until it has set and sufficiently hardened

hardener can be used in the granolithic mix to prevent this. Or to harden and render watertight an old floor some hardeners can be applied to the surface. Silicate of soda can also be used for this purpose, as already mentioned. This chemical is the familiar waterglass in which eggs are preserved, but a special grade is made for treating concrete floors and damp walls. Any builders' merchant will supply.

Steps

York stone was formerly widely used for steps, owing to its hard-wearing quality, but granolithic concrete and brick-on-edge are now more often used in houses. A badly worn stone

step can be repaired if it is thick enough by cutting out the middle portion to a depth sufficient to allow a new surface about 1½ in. deep to be made up with granolithic concrete. The step should be wetted first after the cut-away portion has been punched to form a key for the granolithic. When the granolithic has been laid it should be covered with wet sacking which should be kept damp for a week to retard the drying. This "curing" process will prevent the granolithic from shrinking or cracking.

Brick-on-edge in cement mortar makes a good step provided the bricks are hard. It is a step which a handyman can easily lay. Wet the bricks first and use a straightedge and level to keep the work true. It is an advantage to lay the bricks with a slight forward slope for drainage. Retard the drying out by covering with damp sacking, as just described. A brick-on-edge step should, of course, have a good concrete foundation. If the ends of the step are open they should be finished with brick-on-end which for half their length should be bedded down into the concrete, as in Fig. 5.

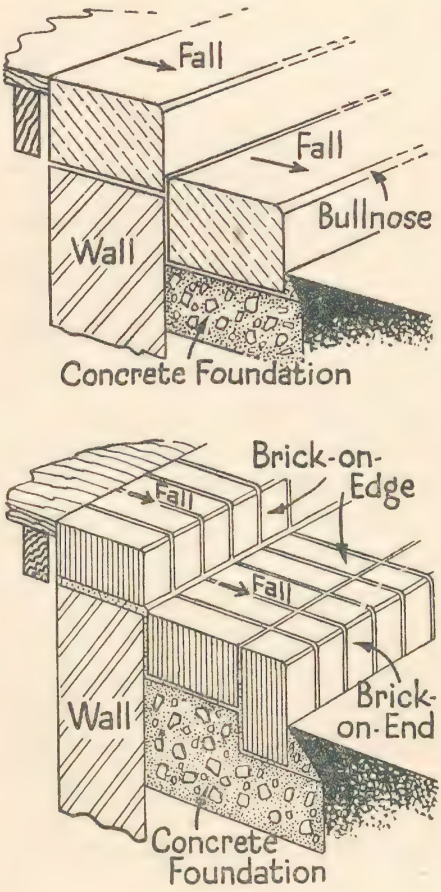


FIG. 5

Top: Stone steps
Bottom: Brick steps

CHAPTER IX

ROOFS

The pitched or sloping roof and the flat roof each have their advocates, and for each a predominance of advantages is claimed. But it is doubtful whether, speaking generally, one has any real lead over the other.

Pitched roofs are suitable for plain rectangular shapes. On irregular plan shapes they are rather costly and often ugly. Flat roofs are well suited to irregular plan shapes since there is no difficulty or elaborate work in roofing any shape, however irregular in outline.

The pitched roof is self-cleansing, but dust and mud accumulates on the flat roof. There is, however, the fact that a flat roof can be used if we so desire. Provided it is constructed with sufficient strength for use (an important point) it can serve as a sun roof or even a roof garden. But to enjoy a sun or garden roof you need a pleasant outlook from it, and that is rare except in country areas. There is no fun in looking into the roofs of neighbouring houses or along rows of suburban gardens.

Pitched roof construction

The pitched roof is a strong structural form as it can be easily triangulated. In Fig. 1 it will be seen that the rafters tend to thrust the walls outwards, but the ceiling joists, which act as ties, prevent this. By a simple arrangement of ties and struts timbers of small section can be used to span the distances normally met with in house construction.

Rafters are usually 4 in. by 2 in. spaced at 15-in. centres for natural slates or clay tiles. The rafters receive intermediate support from one or two lines of purlins, as in Fig. 1. Obviously the purlins need firm support or the whole roof may sag. If it is a roof with gable walls at the ends the purlins bear on to the gable at each end and receive intermediate support from cross walls or timber struts. If it is a hipped roof the purlins receive support from cross walls and/or struts. It is

sometimes difficult to provide adequate support in a hipped roof, as cross walls are not always in a convenient position. In some cases one or two light trusses are necessary. A truss

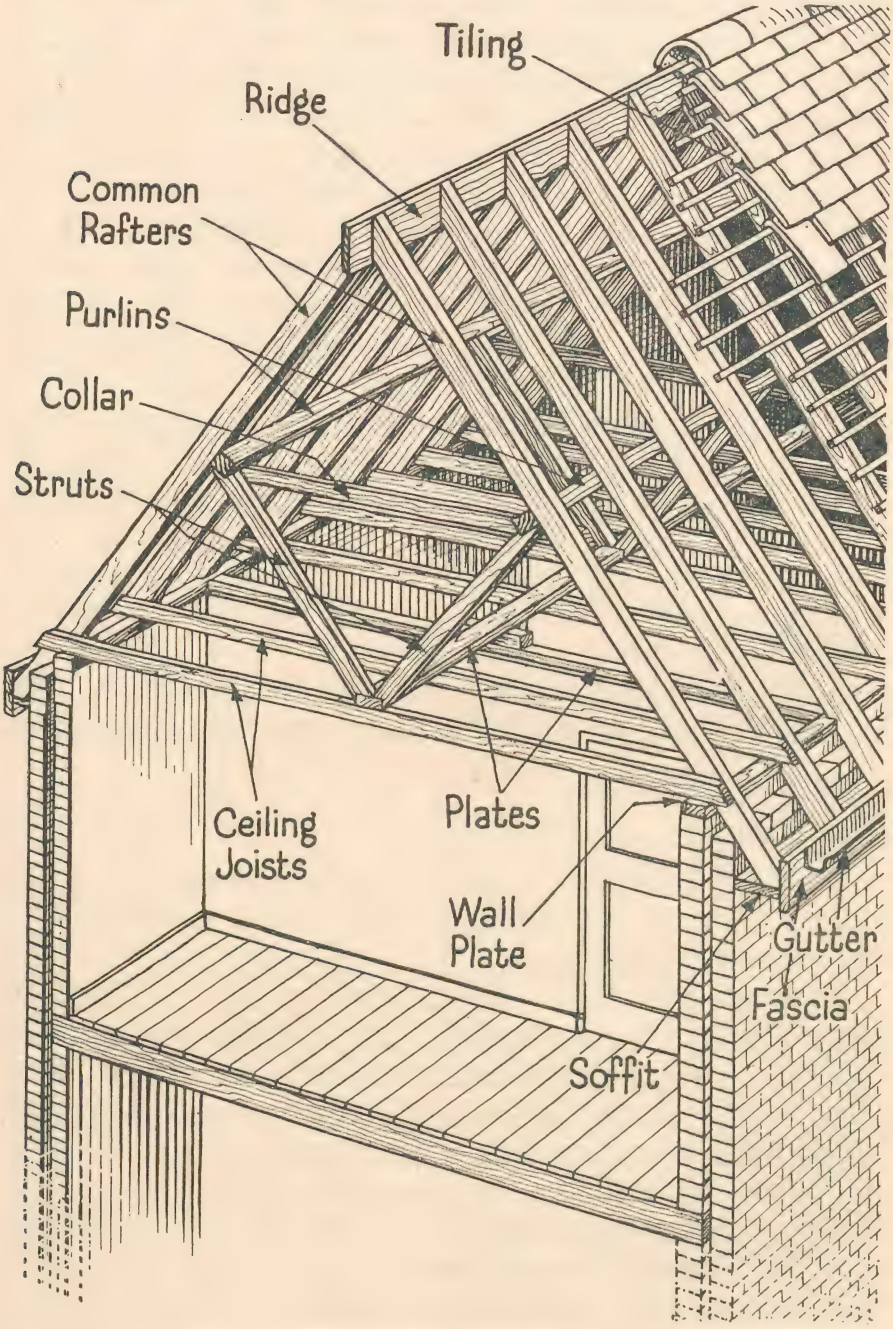


FIG. 1. A PITCHED ROOF
The framing is typical though there are several ways of constructing such roofs

is a framed construction spanning from outer wall to outer wall.

If you have a sagging roof it is due either to the lack of proper support to the purlins or to decay of joint fixings. On inspection of the roof construction you can probably see the cause quite clearly. If a few struts can be placed under the purlins, resting them on the cross walls, further sagging will be prevented. But if the trouble is caused by decay of joint fixings a few ties to prevent the rafters spreading will hold things together (see p. 26). Loose joints should be renailed using 4-in. nails, or 6-in. for the heavier timbers. But in driving nails care is necessary to prevent harmful vibration which might dislodge slates or tiles. In some cases it is advisable to use screws, drilling the timbers to take them.

In very old houses the roof timbers may be decayed. Dry rot rarely attacks roofs as they are well ventilated. The decay is due to periodic soaking with rainwater coming through gaps in the roofing. Unfortunately to replace roof timbers it is necessary to strip the roof. In fact once such a job is started it usually pays to demolish the old roof and construct a new one.

Roofing materials for pitched roofs have already been described in Chapter II, but we can now turn our attention to flat roofings.

Flat roofings

A flat roof must have a slight slope for drainage: 1½ in. fall in 10 ft. is sufficient. The fall must be regular, without hollows in which water could stand.

The construction of a timber flat roof is similar to that of an upper floor, but the necessary fall on the surface is obtained by nailing firrings (lengths of timber sawn to a slope on the upper edge) along or across the joists. The roof is then boarded and covered with the waterproof roofing material.

The cheapest roofing is bituminous felt. Two- or three-layer roofing cemented together with a mastic and properly laid by experienced men will last for many years, but this roofing is not suitable for regular use as a sun or garden roof.

For walking on asphalt provides a durable roofing. This is laid on underfelting. It has the advantage of being easily repairable.

Then there are various proprietary systems of roof paving in which asbestos-cement and concrete tiles are used.

The metal roofings—lead, zinc and copper are durable and neat but not suitable for walking on. If you have to walk over a metal covered flat take care not to tread on the rolls. If these have a solid wood core they will not suffer, but if you tread on a hollow roll it will be damaged. Window cleaners should not

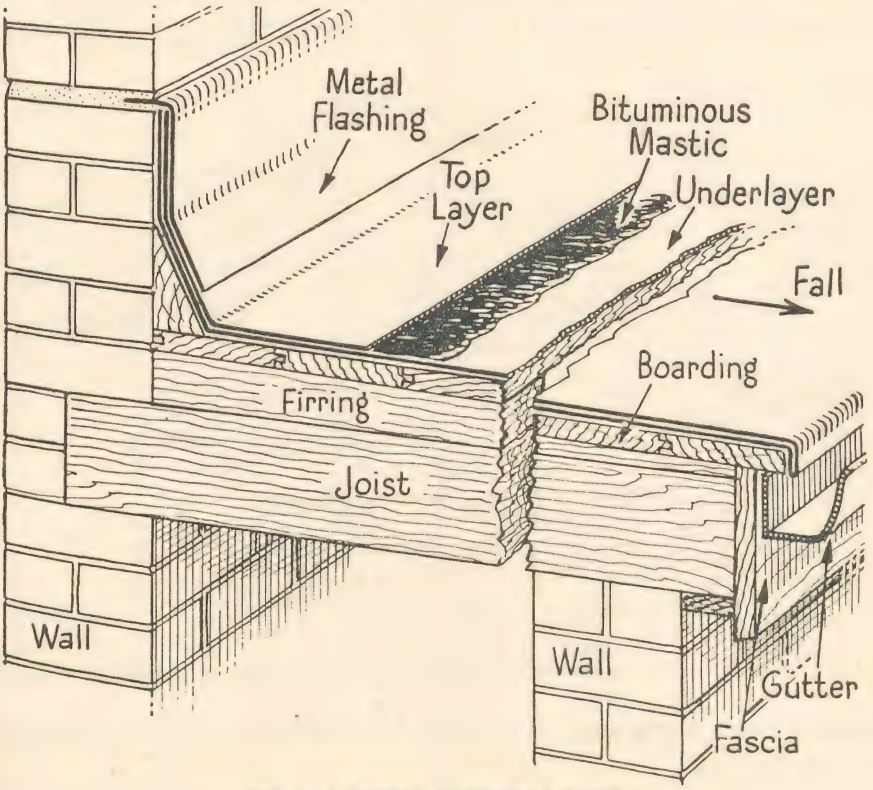


FIG. 2. A TIMBER JOIST FLAT ROOF
The firrings are cut to slope to give the surface a fall for drainage

be allowed to stand on bay window roofs to reach an upper window, as this is a common cause of damage.

Where slight gaps in a pitched roof may not admit water the slightest crack in a flat roof will. Fortunately they can be easily sealed by using one of the proprietary roof repair mastics which can be obtained at any builders' merchant.

Some of these mastic materials are specially prepared for treating pitched roofs, and will seal all gaps and hold loose tiles or slates. The appearance is not attractive, but it is the cheapest treatment for a roof in a bad condition.

Similarly a flat roof which is in bad condition and leaking all over can be sealed by treating with a suitable bituminous preparation.

Eaves

The projecting eaves roof has the advantage of partly sheltering the wall below. Many modern houses with flat roofs have parapet walls with no overhang of roof. There is nothing to be said against this provided that the wall is damp-proof and has a

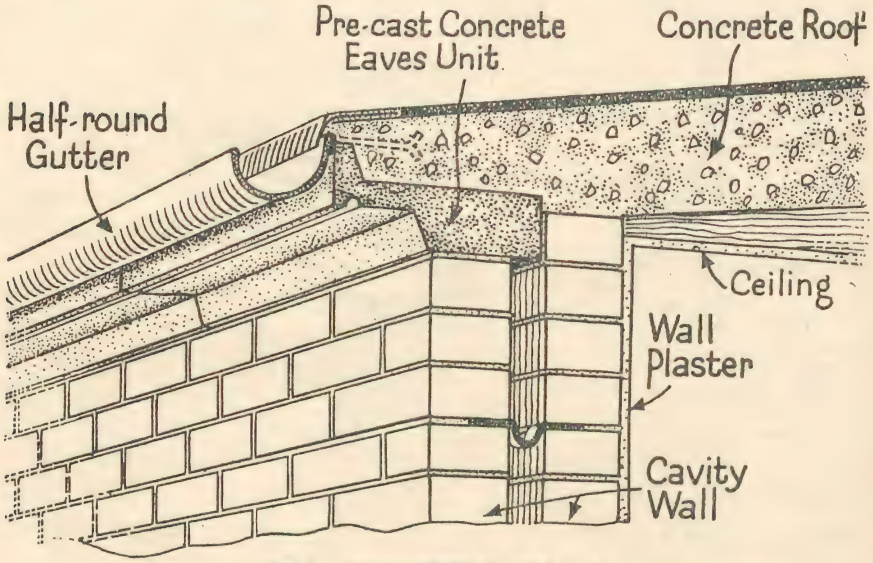


FIG. 3. A CONCRETE FLAT ROOF
The eaves units of pre-cast concrete are rot proof and do not need painting

dampproof course just above roof level to prevent water soaking down the wall.

The projection of the eaves varies from 3 or 4 to 18 in. A 9-in. projection with the gutter additional is a good average.

Eaves may be of the "open" type with the feet of the rafters showing and the wall built up between them to prevent birds entering the roof; or they may be "boxed"—that is, boarded underneath (called the "soffit"), and finished with a "fascia" board at the front. The gutter is fixed in brackets screwed to the fascia board; or if there is no fascia the brackets are screwed to the sides of the rafter feet.

Gutters should be fixed to regular falls so that water runs into the outlets, and the gutter joints should be put together in lead paste or bitumen mastic so that they will not leak. The best

way to repair leakage is to point with mastic. The gutters at the back of parapet walls are usually lead or zinc lined. These, too, can be readily repaired with mastic. Gutters should be cleaned out periodically. If they become stopped up the water usually finds slight gaps through which it penetrates inside.

Verges

The verge is the edge of the roof along the gable end or along the sides of a flat roof. The slope for drainage runs parallel

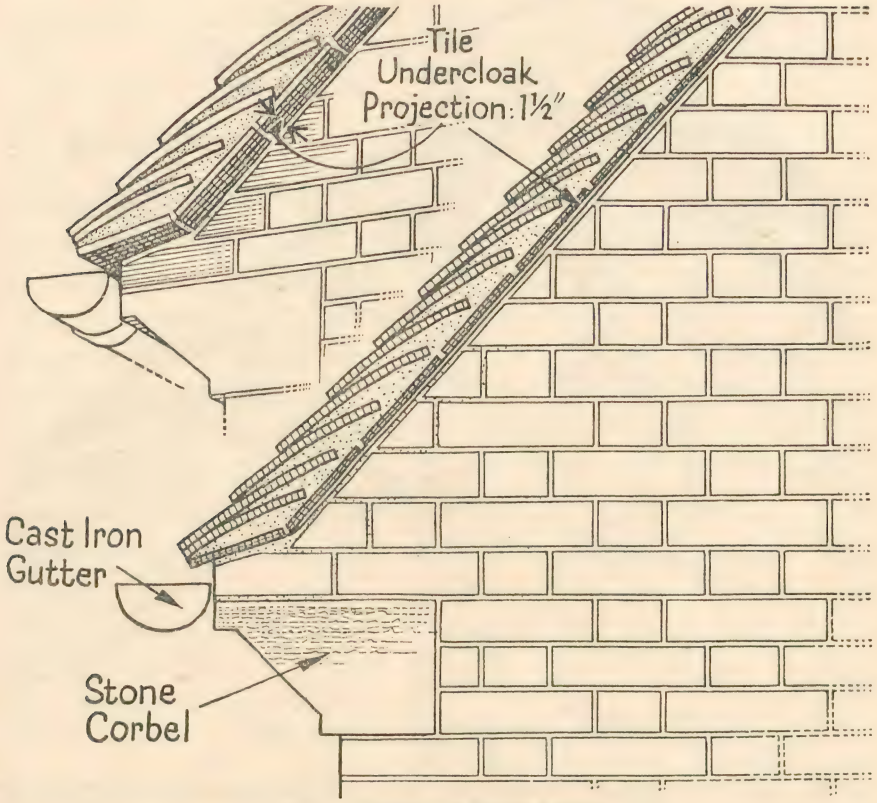


FIG. 4. VERGE OF TILED ROOF
Both tile and slate roofs should have an "undercloak" under the verge, as shown

with the verge, but it is usual to tilt the verge slightly to prevent water dripping over it.

A pitched roof along a gable end may be finished by projecting the roof tiling or slating an inch or so beyond the gable face, and one or two raking courses of brick are often projected to allow more overhang. As with eaves the greater the overhang the greater the shelter given to the wall, and the best way to provide this along the gable is to project the roof with purlins,

ridge and wall plates standing out about 9 in. so that two pairs of rafters can be fixed on the overhang. A pair of barge boards is usually fixed at the end. These are planed and are deeper than the rafters. The tiles or slates project about 1 in. beyond the barge board.

Tile and slate verges should be finished with an "undercloak" course, consisting of a course of tiles or slates bedded on the raking gable wall. This undercloak gives the verge a neat

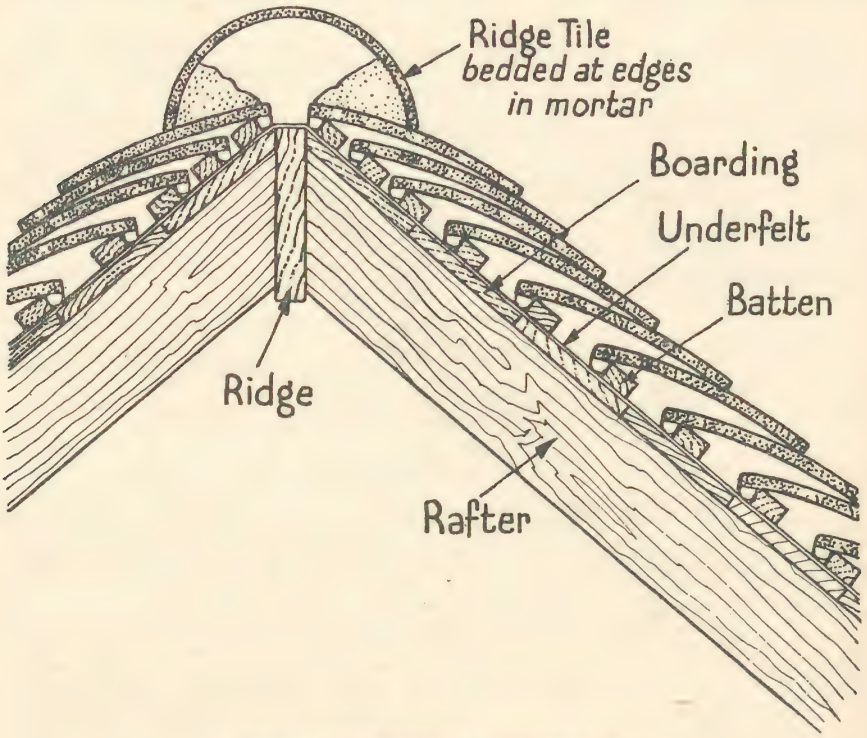


FIG. 5. THE RIDGE OF A TILED ROOF

finish. The space between the undercloak and the roof tiles or slates is pointed with mortar.

Ridges

The wood ridge enables the bevelled heads of the rafters to be secured and also helps to stiffen the roof laterally. The ridge tiles or cresting are bedded in mortar along the two edges on to the roofing. If you replace or repair ridge cresting do not completely fill with mortar, as this will tend to rot the wood ridge, and if frost gets in may crack or displace the tiles. Confine the mortar bedding to the edges of the cresting.

Plain half-round or angular ridge tiles look better than the spigot type.

Hips

In a hipped roof the rafters are bevelled against the hip rafters, and the hip rafter is bevelled against the ridge ends at the head and the wall plate corner at the foot.

The hip covering with tiled or slated roofs may consist of clay hip tiles of which there are several types. The half-round or angular cresting tile may be used, bedding it on the roofing and securing the bottom hip tile with a wrought-iron bar screwed to the foot of the wood hip. But on a small roof this type of hip covering looks clumsy. The hip tiles which "course in" with the plain clay tiles looks neater, especially if it is the "granny bonnet" type shown in Fig. 6.

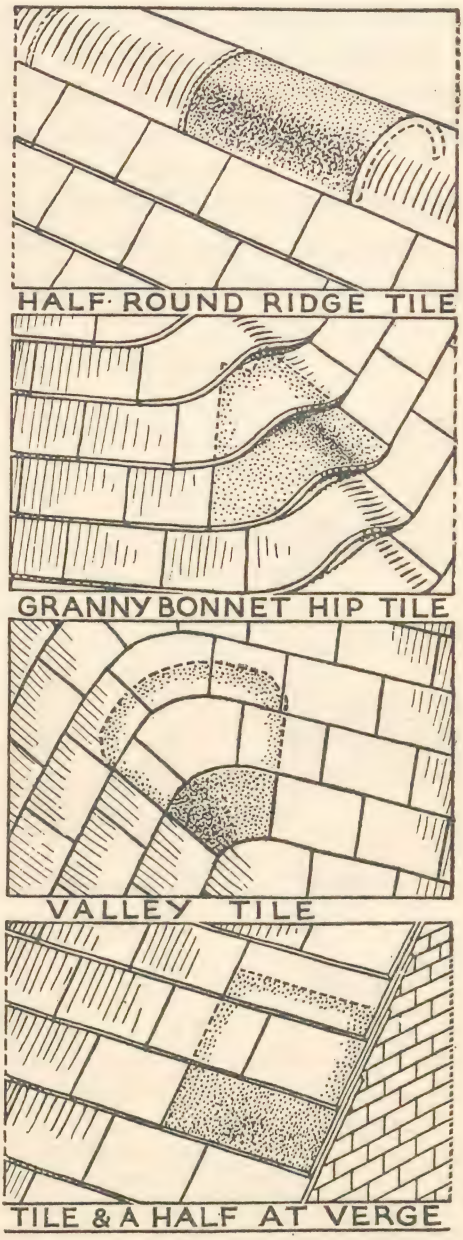


FIG. 6. TILE "FITTINGS" USED IN ROOF TILING

Valleys

Where one roof joins another the line of junction is called the valley. The valley is boarded when it is formed in lead and the tiles or slates are cut along the valley line. Lead valleys are usually of the open type, but there is also a "secret" type which cannot be seen.

The traditional way of forming a valley was to curve the

courses of slates or tiles round the angle. One method is called the "swept" valley and the other the "laced." These old methods look well but are rather costly.

Special valley tiles are now commonly used with plain tiled roofs. These have an internal angle and "course in" with the plain tiles. They make a neat and weathertight valley.

Asbestos-cement roofings

These are of three main types. There are the large corrugated sheets, the small slates and the imitation pantile units.

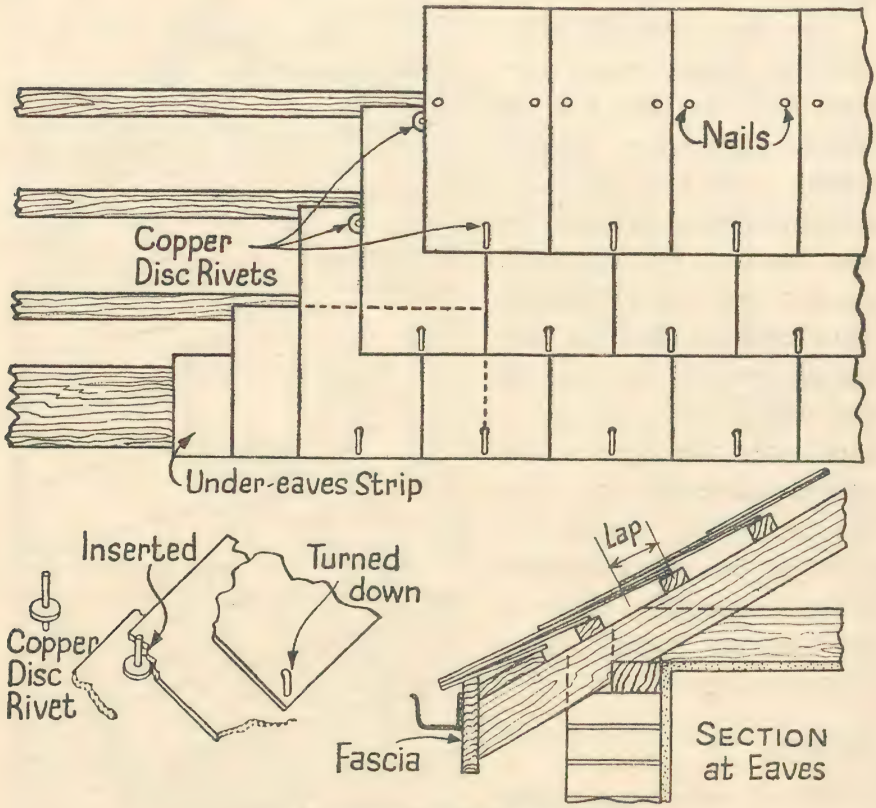


FIG. 7. ASBESTOS-CEMENT SLATING
There are two patterns—straight cover and diamond cover

The large sheets are very good for covering garages and outbuildings as they are durable, fireproof and easily fixed. Asbestos-cement does not require painting and the material hardens with age. It is, however, rather brittle though it will withstand moderate knocks.

The corrugated sheets (Standard type) are made 3 ft.–10 ft.

long in 6-in. increments, with a width of 2 ft. 6 in., or a net covering width when laid of 2 ft. 1½ in. They can be drilled and sawn, and are fixed to timber framing with screwnails fitted with cupped lead and asbestos washers. Asbestos-cement should not be rigidly fixed, so fixing holes should be slightly larger than the screws or bolts. This prevents slight roof movements from straining the roof sheets.

Asbestos-cement slates are made in three sizes in the ordinary straight cover, and there is also a diagonal cover. In addition to the natural grey, there are blue, red, russet brown and brindled. As the material is much lighter than clay tiling or natural slates the rafters can be spaced at up to 2 ft. 6 in. centres. Each asbestos slate is fixed with two galvanized nails, 1¼ in., 11 B.W.G., with a copper disc rivet at the lower edge which secures the slate against wind lift.

Use roof ladders when working on any kind of asbestos-cement roofing. The sheets especially are dangerous to walk on unless of the reinforced type.

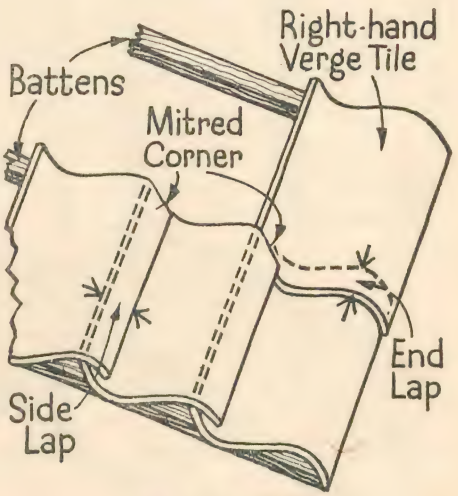


FIG. 8. PANTILES
A traditional type of single lap tile

Pantiles

These are single lap tiles, while plain tiles have a double lap. Pantiles are lighter than plain tiles, though they must be perfectly regular in shape if the laps are to fit properly and keep the weather out. Underfelting should always be used as in rough weather some rain is bound to blow through.

Patent interlocking pantiles are made which are more weather resisting than the old type, but even these should have underfelting. Verges and eaves should have an undercloak of plain tiles, and double roll tiles should be used at the verges.

Interlocking tiles

These are single lap tiles with interlocking projections and grooves at the head and side laps. There are many proprietary

patterns, some of them made in France and Belgium (the "Marseilles" and the "Courtrai-du-Nord" are two well-known types). Distorted tiles should be rejected as they will not interlock properly. Underfelting is advisable, especially in an exposed position.

Pantiles and interlocking tiles look best on large areas of roofing with gables. Hips and valleys look rather clumsy. They make

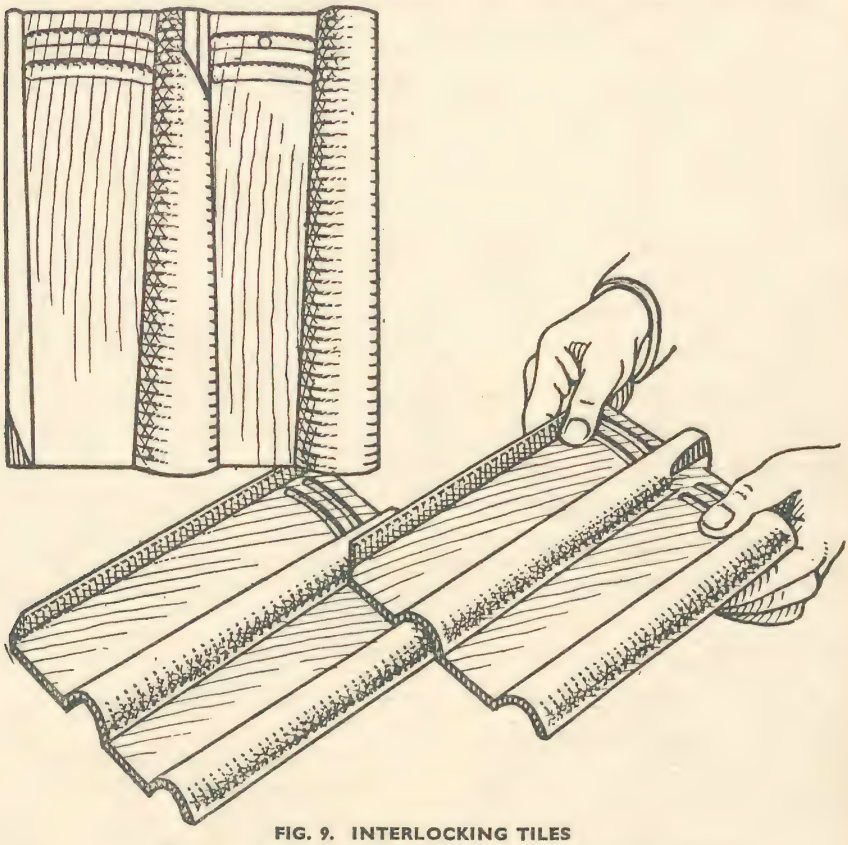


FIG. 9. INTERLOCKING TILES
There are weather checks on the laps to keep the water out

a lighter and cheaper roofing than plain tiles and can be used at a pitch of 30 degrees.

These tiles should not be torched with mortar underneath, though small leaks can be stopped with mortar. With a badly leaking roof the only remedy is to take the tiles off and lay underfelting, then retile.

Shingles

Old shingles are mostly of oak, split from the log. But modern shingles are of red cedar—a rotproof wood imported

from North America. These shingles are 16 in. long with widths of from 3 in. to 12 in. They make a light, durable roofing of good appearance. Each shingle should have two nails for

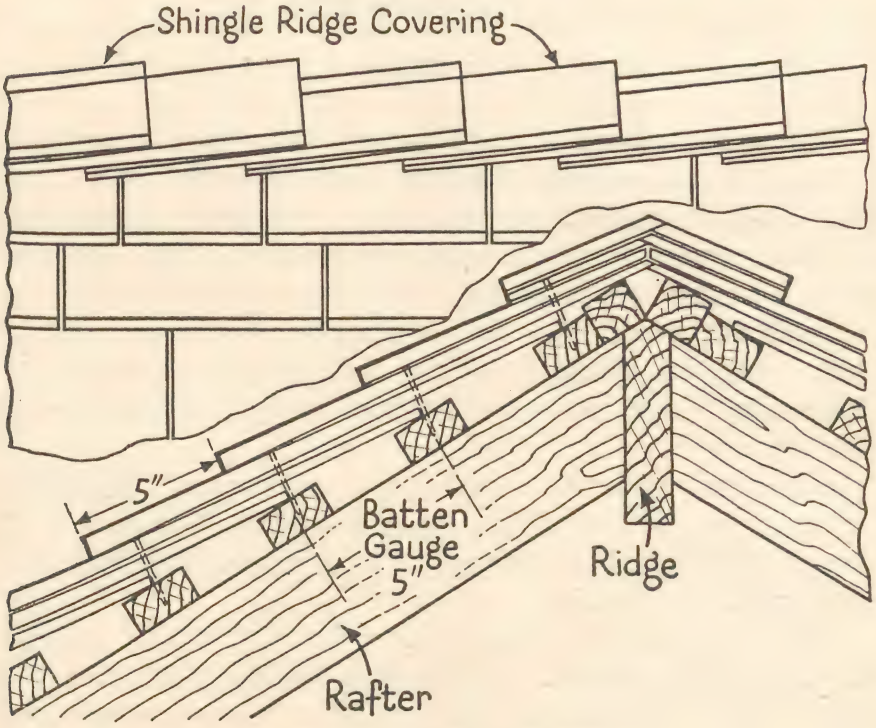


FIG. 10. SHINGLED ROOF DETAIL
Red Cedar shingles are now widely used, this wood being very durable

fixing, $1\frac{1}{8}$ in. long, 15 gauge, galvanized or of copper. Being light shingles are easy for the handyman to fix and are suitable for bungalows, outhouses, summerhouses, etc. The maker's instructions should be carefully followed in laying.

CHAPTER X

CEILINGS

The ceiling between a lower and an upper floor is merely a lining to the underside of the floor joists. A ceiling over a top floor is a lining applied to ceiling joists. As already mentioned, in house construction with pitched roofs the ceiling joists also serve as tie members to prevent the thrust of the rafters pushing the walls outwards. With flat roofs the ceiling lining is applied to the underside of the roof joists, unless it is a ceiling of the "suspended" type which has separate ceiling joists below the roof structure.

If the floors or flat roofs are of reinforced concrete, or of pre-cast concrete units, the ceiling lining is applied to the underside, though the method of attachment is different from that used with timber construction.

Ceiling joists over bedrooms are usually 4 in. by 2 in. in small houses. This is not stiff enough for spans over 8 ft., though a binder beam is fixed over the middle of the ceiling and the ceiling joists are nailed to this to give intermediate support. It is better, however, to use ceiling joists 5 or 6 in. deep. This will do much to prevent cracked plaster.

Ceilings can be lined with plaster or with one of the many sheet materials now available. Are these sheetings better than plaster? Well, a sheet material does not crack and will stand considerable vibration where a plaster ceiling would crack badly. But for ordinary situations there is little risk of serious cracking in a plaster ceiling provided that the ceiling structure is stiff enough and that the lathing and plastering is soundly done.

Plaster ceilings

On ordinary wood joists wood laths are used. It is important that the space between laths should be $\frac{3}{8}$ in. wide so that the plaster can be forced through and slightly over the backs of the laths. Thus the plaster is securely keyed to the ceiling structure.

Butt joints at the ends of laths should be staggered—that is, they should not line up on one joist. If they line up a line of weakness is formed which may cause a bad crack to develop.

Plaster on ceilings is usually three-coat work. The undercoats are usually of lime plaster while the finishing coat is a hard plaster (there are many proprietory types of hard-setting plasters, which are manufactured from gypsum. They set at moderate rate, but not so quickly as plaster of paris which is much too quick for ordinary use). Each coat should be allowed to dry out before applying the next, and the undercoats should be cross-scratched to form a key for subsequent coats.

Cracked ceilings

Before dealing with a defective plaster ceiling the type and the cause of the defect must be studied. If the plaster is falling off

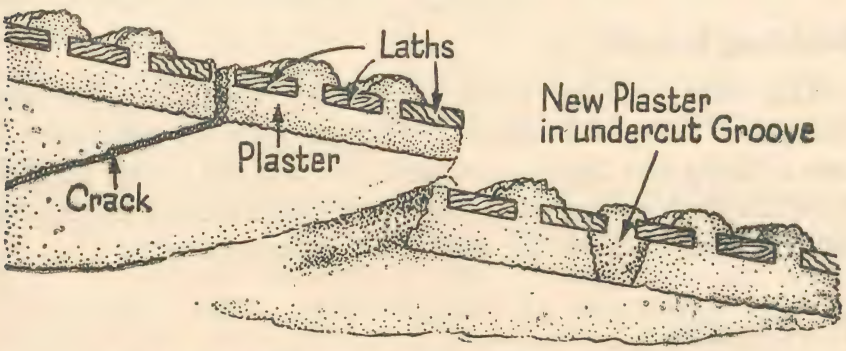


FIG. 1. HOW TO REPAIR A CRACKED PLASTER CEILING
The crack must be undercut as shown

the lathing and the ceiling has cracked up into loose "islands" which are obviously liable to collapse, then the whole of the plaster should be removed.

If there are merely fine crazes it will be found that a coat or two of distemper or whitewash will fill them. Very fine crazing is unavoidable and is nothing to worry about.

If there are deep cracks they can be repaired, but in a fairly new house it is better to wait a while to see if the cracks will develop. To repair a crack do not merely fill with new plaster. First take a stiff-bladed knife—a large penknife blade will do—and undercut the crack to a v-shape, widening it at the same time so that the plaster can be easily forced in and the v-shape will prevent it dropping out. To fill the crack use a proprietary

hard plaster, or adamant, and mix according to the maker's instructions. Wet the crack slightly before applying the plaster —but do not soak it. Trowel it flush with the ceiling. When dry apply distemper to the new plaster before redistempering the whole ceiling.

Some people prefer to hide a defective plaster ceiling behind ceiling paper. This is not advisable as some day the paper will have to be stripped and will probably bring much of the plaster with it.

It is obvious that the key provided by the lathing is greatly weakened where the laths cross the joists. This is of no consequence provided that the joist is not more than 2 in. wide. Above this width counter-battens should be used, nailing them on to and parallel with the joists and nailing the laths to and across the battens.

Building boards

The sheet materials which are suitable for ceiling and wall linings are many and various. They all have the advantage of ease in fixing and they do not crack, but it is not always possible to have a flush surface as in many cases some kind of cover strip must be used to cover the butt joints between sheets.

Fibreboards

These are made of shredded or pulped wood fibres, processed and compressed. Of ordinary fibreboard there are two kinds: the moderate density boards which are suitable for general purposes in lining ceilings and walls; and the low density boards which are thicker but have not been compressed to the same extent—these are often called insulation boards as they have good sound and thermal insulating properties.

Ordinary fibreboards are absorbent and will burn. But there are special kinds which are damp resistant and non-inflammable.

Flat decorated and glazed asbestos-cement sheets and plywood can also be used for interior lining (see p. 34).

Plaster board consisting of hard plaster in sheets is made with a smooth finish for decorating and with a rough surface for finishing with a skimming coat of plaster. In the latter case it

acts as a lathing, too, and if the skimming coat is properly applied there is no danger of cracking.

All building boards are nailed to wood grounds. These grounds must provide support to the four edges of each board and also some intermediate support. They are nailed with 1-in. round wire nails at 6-in. intervals along the edges and at 9-in. intervals over intermediate battens. The usual method of covering the joint is by nailing wood strips or mouldings over, thus producing a panelled effect. It is, however, a mistake to try to imitate traditional panelling—the effect is merely shoddy and cheap. Some of the best effects are obtained by fixing the sheets horizontally.

There are methods of making a flush surface, but these are not always successful owing to shrinkage and expansion. One method is to cover the joint with canvas or strong paper and then to paper the whole wall or ceiling.

On ceilings and wood studded partitions the boards can be fixed direct to the joists or studs, provided that they are reasonably regular, but it may be necessary to cut the standard boards to suit the joist or stud spacing.

In old houses you may find ceilings of the exposed-beam type. There are two kinds: one in which the underpart of all the floor joists are exposed, and the other in which one or more beams are exposed. These beams support the floor joists, and are usually of oak. Strictly speaking exposed joists are not approved under the byelaws, which require the woodwork of floors and ceilings to be covered underneath with fire-resisting material such as plaster. It should also be remembered that ordinary fibreboard of the kind that is not fire-resisting should not be used on the ceilings of permanent houses. The fire-resisting type should be selected.

CHAPTER XI

PARTITIONS

A house of normal construction has comparatively thick outer walls with thinner partition walls and partitions. A partition wall consists of strong load-bearing material such as brick or concrete. A partition of the non-load-bearing kind is of lighter construction—lath and plaster on timber studs, lightweight concrete blocks, etc. It is useful to be able to distinguish the difference, especially if you contemplate altering your house.

If a partition wall is of brickwork plastered both sides it will be about $6\frac{1}{4}$ in. thick—$4\frac{1}{2}$ in. of this being brick and the rest plaster. Knock it with your knuckles or a light mallet and it will give a dull "solid" sound which will be the same wherever you knock all over the wall. Drive a nail in, and unless it strikes a mortar joint you will "feel" when it strikes the brickwork.

A timber stud partition covered with plaster will give a "hollow" sound when knocked, though over the timbers the sound is not so hollow as between them. As the studs are usually 4 in. by 2 in. the total thickness of the partition will be only slightly less than the brick partition wall. But if you drive a nail in the studded partition you will either strike the wood stud or the hollow space between.

In modern houses partitions are often of lightweight concrete or hollow clay blocks, and these are not so easy to detect, though as they are rarely more than 3 in. thick, the total thickness with plaster both sides is about $4\frac{1}{2}$ in., which is less than with solid brickwork or 4-in. studs. In case of doubt if a small patch of plaster is removed the partition material will be revealed.

Brick partition walls

Constructed of solid brickwork in stretcher bond; half-brick, $4\frac{1}{2}$ in., thick, these walls are used to support loads. Floor and ceiling joists may be supported on them, and they are sometimes built up into the roof to support purlins, though another common method is to strut the purlins from the partition walls.

Most partition walls in houses are carried up through both ground and bedroom floors. So if you want to cut out the ground floor portion of the wall you must provide support for the upper portion and for any floor or other loads which the wall is carrying. This is done by underpinning to provide temporary support while a steel or other beam is inserted over the proposed opening. This is a job for experienced builders.

Cutting an opening for a doorway in a load-bearing wall is an easier matter, though a lintel must be inserted over the doorway to carry the loads above.

A partition wall is built off a foundation from firm subsoil and has, or should have, a damp-proof course to prevent damp rising from the ground. A rather common defect in this connection is to have the damp-proof course too low where there is a timber floor on one side and a solid concrete floor on the other, thus allowing damp to rise from the ground. This will only happen if the ground under the floors becomes very wet. Such dampness will be indicated by discoloured patches both sides of the partition wall, being worst near the skirting. This point is illustrated on p. 99.

Timber studded partitions

The ordinary non-load-bearing studded partition consists simply of uprights called "studs" with a horizontal plate at the bottom and another at the top. In most small houses the studs are skew nailed to the plates. This is not good practice, as it allows the studs to move slightly resulting in cracked plaster. Studs in good class work are stub-tenoned into the plates.

In old houses you may have trussed partitions which bear loads. These are usually strongly constructed and jointed. Obviously you should not cut openings in such partitions unless you arrange for the loads to be carried by beams or other means.

There is a type of trussed timber partition which is fixed on an upper floor and is so framed that it transfers most of the load to the walls. Such a partition may support roof loads and, of course, could not be removed without disastrous consequences.

Fireproof partitions

The modern blocks of lightweight concrete and hollow clay are fire- and rot-proof, and if properly laid are perhaps not so

likely to shrink and crack the plaster as timber partitions. The hollow clay type has keyed surfaces which give strong and uniform bond between surface and plaster. There are also

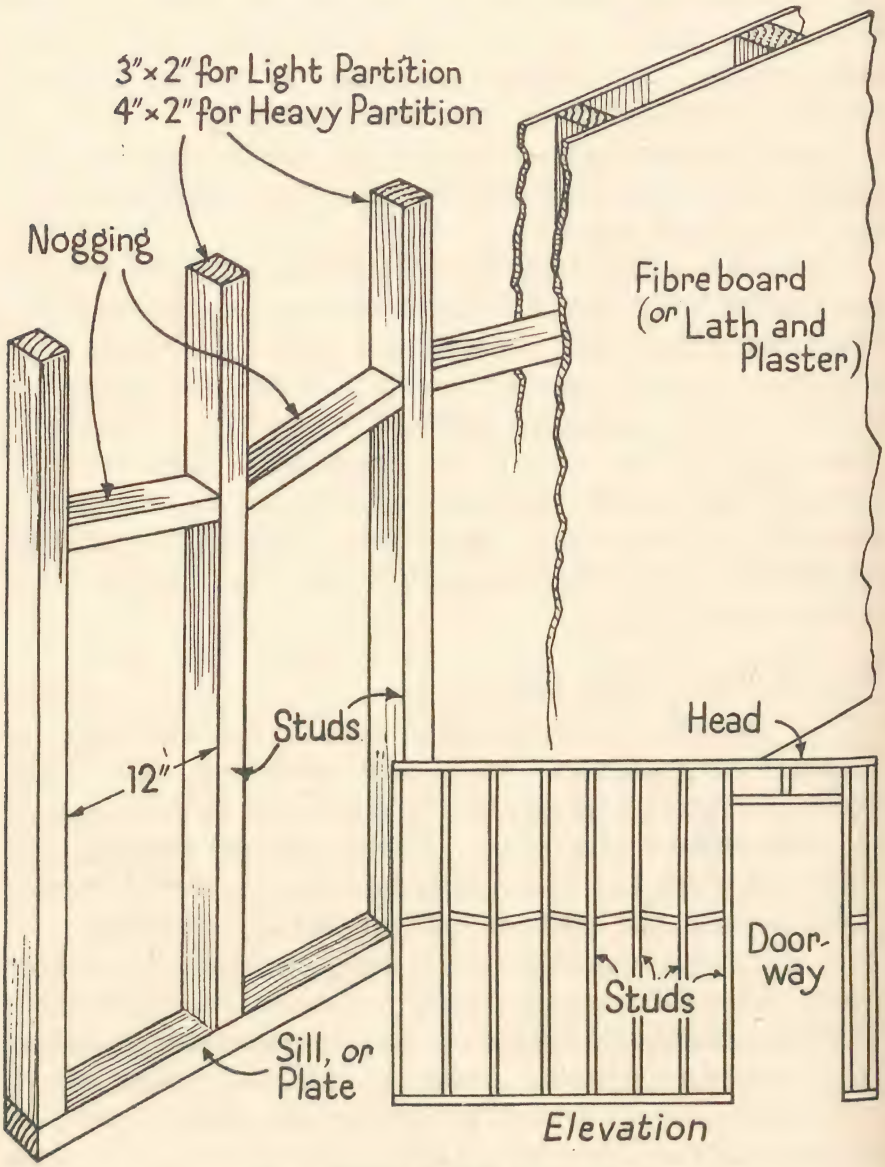


FIG. 1. TIMBER STUDDED PARTITION

This type is widely used for bedroom partitions, the frame being lathed and plastered both sides

partition blocks of reinforced plaster which are very light and easily laid.

Although these block partitions have adequate strength for their purpose, most of them are not designed to carry loads.

If nails are knocked into them there is some danger of disturbing a block and so cracking the plaster rather badly.

Plaster on expanded metal

This type of partition is also fire- and rot-proof, and is of the non-load-bearing type, unless it is a double partition with interior framing.

The earlier single partitions consisted of ordinary expanded metal lathing wired to steel rods which were secured top and bottom to plates or beams. But this has been superseded by the modern ribbed expanded metal fabrics, in which channel ribs are incorporated which stiffen the fabric and no reinforcing rods or framing are required. The fabric is plastered both sides and makes a thin but stiff partition. Nails cannot be driven into such partitions and there are special methods of fixing picture-rails, etc.

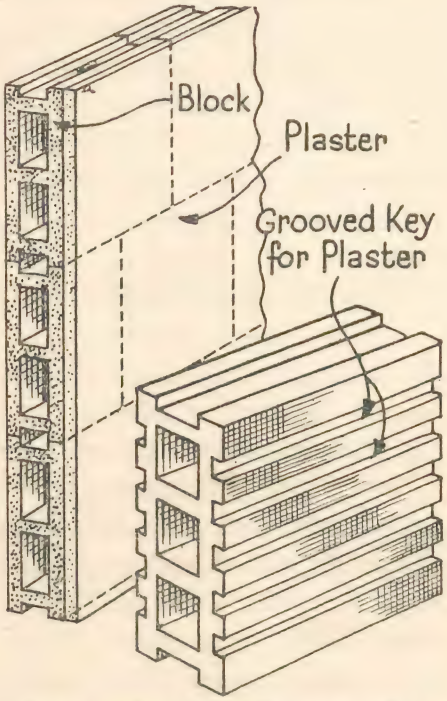


FIG. 2. HOLLOW PARTITION BLOCKS
These have high fire resistance. They are made in several thicknesses, 3 in. and 4 in. being commonly used in house construction

Sheeted partitions

Fibreboard, asbestos-cement sheets and plywood can be used to face timber studding to form partitions. Such work is well within the ability of the average handyman. Proceed as follows: Measure the width and height and repeat the measurements in several places as they may vary, especially in an old building. If possible arrange to build your partition over a floor joist (indicated by the line of nails in the floorboards). Make a drawing of the partition framing—if possible to scale. The sawn timbers should be 3 in. by 2 in. The framing may consist simply of a horizontal plate laid on the floor with a head plate and the vertical studs between. If you are fixing the sheeting vertically you must have studs to take the edges of the

sheets. If you are using 4 ft. wide fibreboard sheets your studs should be spaced at 2-ft. centres. But if you are fixing the sheets horizontally you must have studs arranged to allow the ends of the sheets to be nailed, though, of course, you can cut the sheets to suit the stud spacing.

The studs should be stiffened by nogging pieces, which are short lengths cut to a trifle more than the space between studs so that they can be tightly wedged between, as in Fig. 1. They are skew nailed when in position.

If there is to be a doorway the transom piece over should be jointed into the studs on either side with a mortice and tenon joint, the tenon standing out and having a square hole into which a wedge is driven. This makes a rigid frame to which the door lining can be nailed. A simpler joint than the tenon just described is the skew housing shown in Fig. 4, p. 194. This joint has to be nailed.

While the partition framing described is strong enough for most small house partitions, if the length is over 10 ft. it is advisable to stiffen it by diagonal struts. The struts are continuous while the studs are cut to bevel against them. These bevelled stud ends are skew nailed to the struts.

Very small partitions, as between a bathroom and w.c., can be constructed with a single thickness of sheeting. The framing should be planed and grooved to allow the edges of the sheets to be inserted. The middle of the sheet should be stiffened with battens both sides. If you want such a partition to be impervious and easily-cleaned use glazed asbestos-cement sheets.

CHAPTER XII

FIREPLACES AND CHIMNEYS

The fireplace for an open grate burning solid fuel is simply a three-sided enclosure. It has a flue over it, usually 9 in. by 9 in. or slightly less, which is carried up to the chimney. Several fireplaces and flues may be built into one stack. This is economical, especially when fireplaces are built back-to-back.

The design of a fireplace and flue should ensure that smoke is carried upwards under all weather conditions. More is now known as a result of recent research about fireplace and flue design for domestic fires, and if modern principles are applied down-draught can be avoided in most positions.

The model by-laws lay down certain conditions of construction designed to prevent woodwork catching fire. Thus, the hearth must be of solid incombustible material 6 in. thick and must stand forward at least 18 in. and extend on either side of the fireplace opening at least 6 in. Timber beams and fixing pads must not be built into the chimney breast or flue wall and where woodwork adjoins a 4½-in. chimney breast the surface of the brickwork or concrete must be rendered in mortar. The need for these precautions is proved by the fact that in old cottages and houses fires sometimes result from timber being too close to the inside of the flue.

Prevention of down-draught

The best size for the flue is about 9 in. by 9 in. It should be lined, either by mortar pargetting, or preferably with fireclay flue liners. Pargetting cracks up and falls off the flue walls in time, and, of course, it is impossible to renew it. Fireclay liners will not crack up provided that the flue is not frequently overheated and that the chimney is swept at reasonable intervals. They give a smooth durable lining and improve the thermal insulation of the flue. They also reduce the amount of heat passing through the flue wall and prevent risk of fire through flames passing through decayed joints to adjacent timber.

It is a generally accepted principle that there should be some kind of contraction over the fireplace, but that the flue should then run straight up to the chimney top, if possible. Bends are, however, often inevitable where several fireplaces are built in

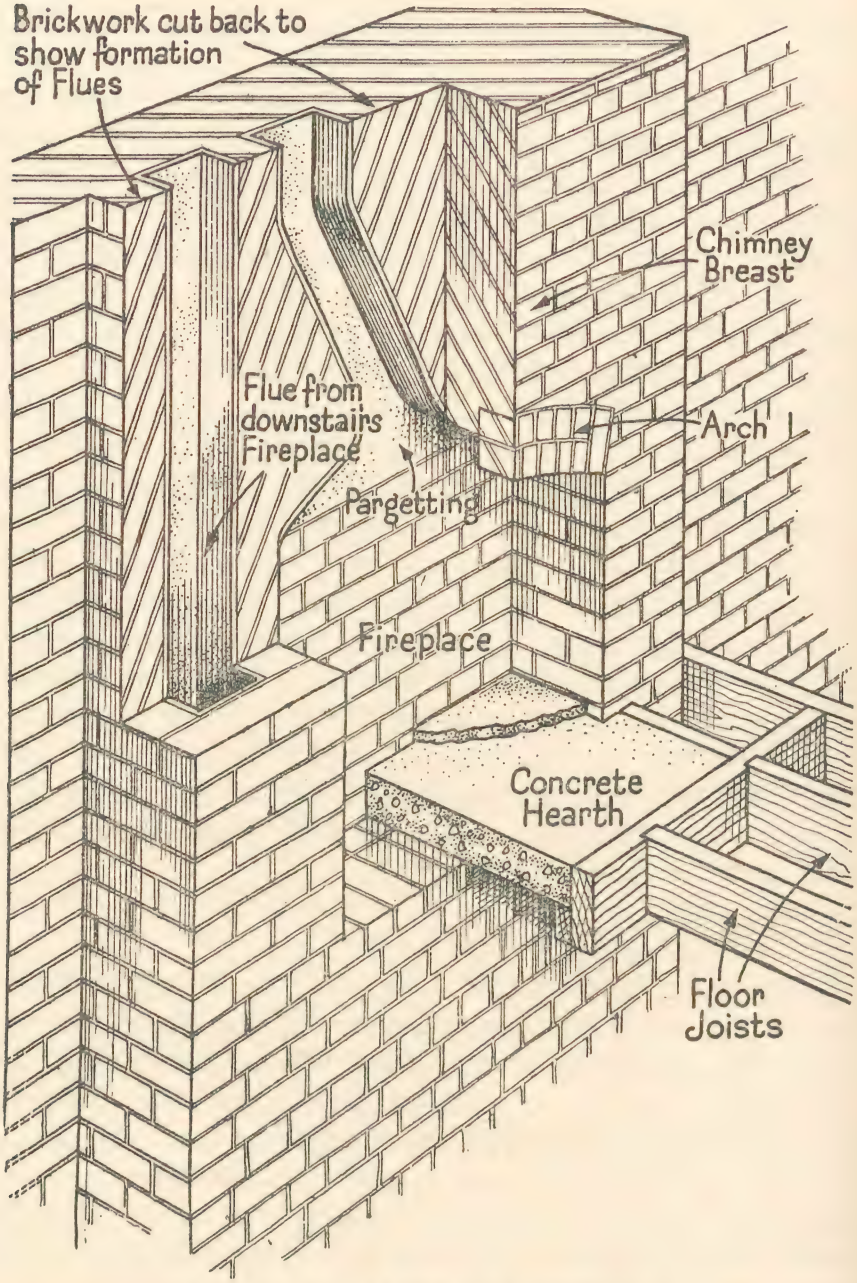


FIG. 1. FIREPLACE AND FLUE CONSTRUCTION

This detail shows an upstairs fireplace. The drawing indicates the formation of the flues and the hearth

one stack. Bends are not likely to cause down-draught provided that they are not sharp in angle. A change of angle of not more than 20 degrees is quite reasonable. Incidentally very sharp bends make cleaning difficult. If there is a bend it should occur just over the fireplace, not high up the flue.

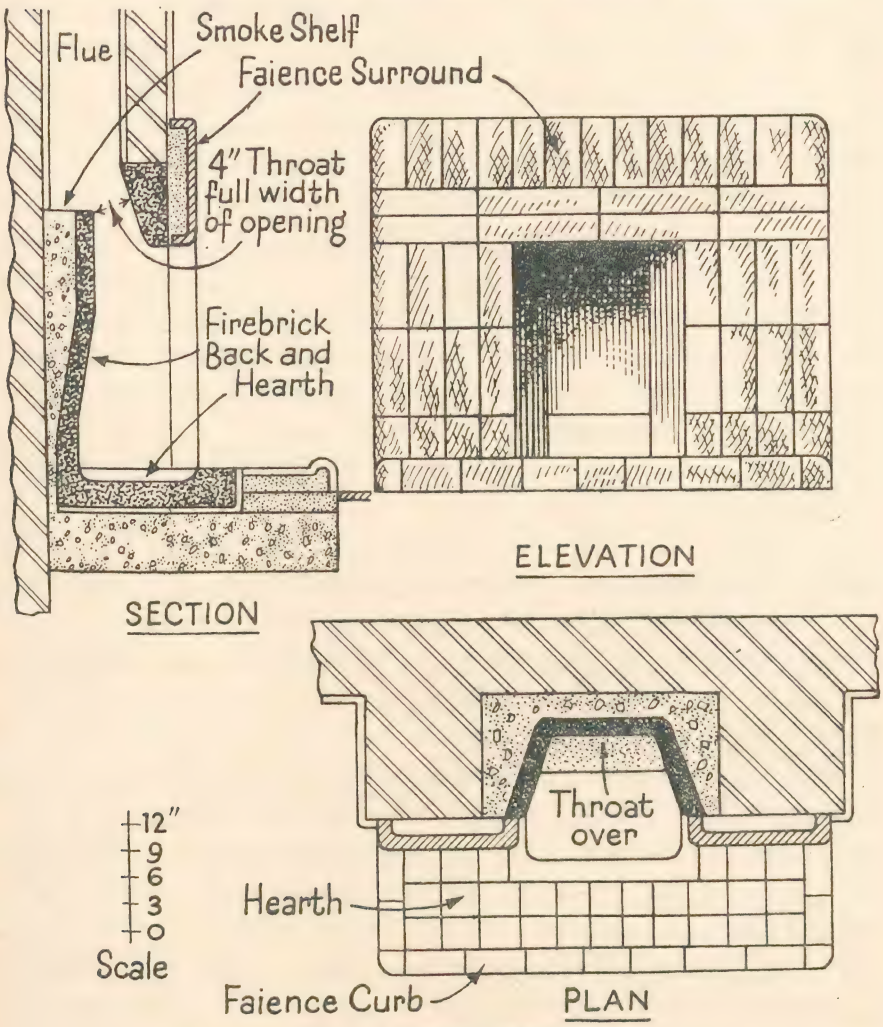


FIG. 2. A MODERN FIREPLACE
The interior has been designed to encourage a steady up-draught

Fig. 2 shows a fireplace designed on what are called the Rumford principles. Although these were discovered in the eighteenth century they have been tested and approved in recent years at the Building Research Station. The chief features are the size and position of the throating and the smoke shelf. The shape of the fireback is also different from the normal. If your

fireplace differs greatly from this, as it probably does, it does not follow that down-draught must result. There are many other factors to be considered.

It is most important that the top of the chimney should be well above the level of adjoining buildings, trees and ground. Ground level may seem to be quite outside the problem to dwellers in flat country, but in western districts, and in Wales and Scotland, where houses are built against hillsides, it may cause down-sweeping winds and suction areas which are very difficult to deal with.

Under the model by-laws the chimney top must be at least 3 ft. above the level of the adjoining roof. But this is for fire prevention. For down-draught prevention it is advisable to have the chimney top well above ridge level, even if the chimney is at or near the eaves. In the case of a bungalow or a flat-roofed building it may be necessary to raise the chimney 10 ft. or more above the roof.

Principles of up-draught

It is well known that warm air rises, so that when a fire is lit in a grate the warm air above it immediately rises carrying with it the smoke and gases of combustion. As the warm air is drawn up the flue it must obviously be replaced by air entering the room. In most cases cold air is drawn under doors and through slight gaps around window frames.

Unfortunately, this cold air being drawn into the room may result in uncomfortable draughts. But if the doors and windows are made draught-tight there will be insufficient air for the fire and the result will be down-draught, smoke being blown back into the room.

A better way of obtaining the necessary air supply is to take it from air inlets in the wall close to the hearth. These should be adjustable so that they can be partly closed if the wind is blowing strongly or in the wrong direction. For with the wind in certain directions air may be sucked *out* of the room through these inlet grilles. It will be seen that this problem of air supply to the fire is an awkward one. If you have a fireplace in which down-draught is experienced try opening the room door. If down-draught is then discontinued it is a proof that insufficient air supply is the cause of the trouble.

Flue insulation

The warmer the air the quicker it rises, and from this fact it follows that the flue walls should retain a certain amount of heat. Brickwork and concrete are good insulators, though dense concrete is not so good as brickwork, but in any case a 9-in. thickness is better than the more usual $4\frac{1}{2}$ in. employed in flue and chimney construction. The thicker walls will also not admit damp so readily as the thinner, and damp tends to make a flue cold. Fireclay flue liners, as already recommended, improve thermal insulation and also encourage up-draught by the smoothness of the surface.

It should be noted that if the flue is not regularly swept the surface is roughened with soot and the friction reduces the up-draught. Also, the area of the flue section is reduced until the smoke and gases cannot rise fast enough, and periodic down-draught results. This is quite apart from the danger of soot accumulations catching fire. The overheating of the flue walls and lining may cause the joints to crack.

The chimney

The outer walls of most chimneys in small houses are only $4\frac{1}{2}$ in. thick, and though this may be strong enough in a stack of several flues it is better to have the outer work 9 in. thick for the sake of the better insulation, as just described.

The chimney top should be made weathertight and chimney pots should be firmly bedded down so that gales will not blow them off. There is, by the way, nothing beneficial in a chimney pot. It is better to build up the chimney a little higher and omit the pot. Where fireclay flue liners are used the top one may project a few inches. If pots are used they should be bedded at least 6 in. (two courses of brickwork) down.

The top of the chimney should be flaunched, which consists of covering it with cement mortar of fairly strong mix and trowelling the surface to an outward slope to throw the rain-water away from the pots or outlets. Most chimneys have projecting courses at the head and these should be weathered on top by a sloping cement fillet. The pointing of a chimney should be kept in good condition. If it is neglected slight movements may start in the joints until the whole chimney is seriously weakened.

As the chimney is in an exposed position it absorbs a lot of water during a rainy period. This may soak down and cause damp patches to appear on the chimney breast or ceiling immediately below. To prevent this a damp-proof course of slates in cement mortar or impervious brick should be built into the chimney where it emerges from the roof. There is no such

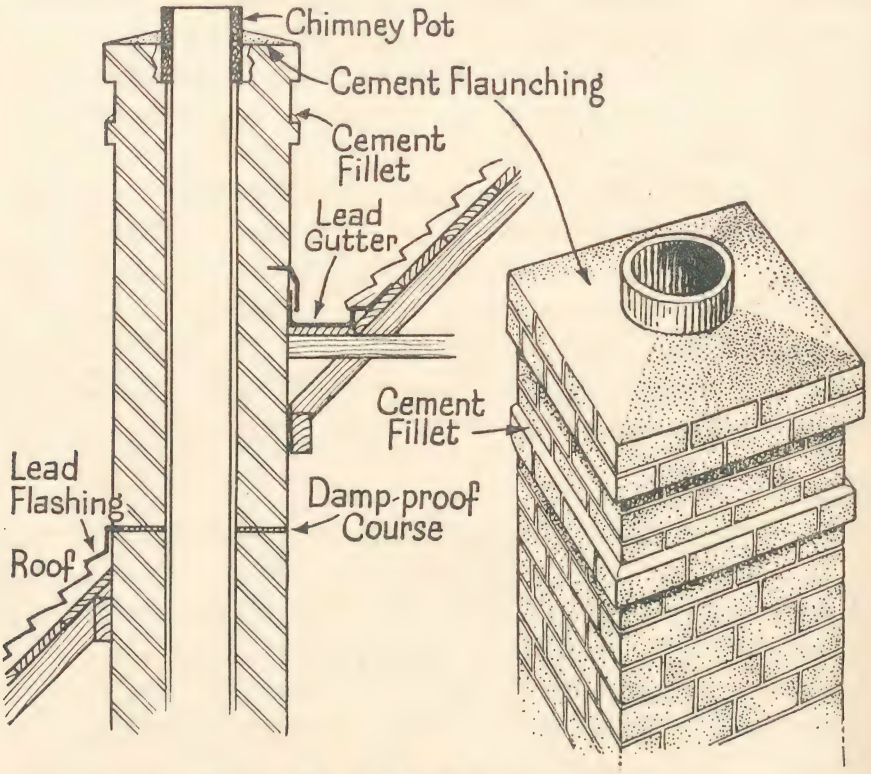


FIG. 3. HOW A CHIMNEY IS CONSTRUCTED
The cement flaunching on top prevents rain soaking the brickwork, and the flashings and damp-proof course make a watertight junction at roof level

damp-proof course in an old chimney, nor in many modern ones, and if there is no dampness of the kind just described there is nothing to worry about. To insert a damp-proof course in an old chimney the courses of brick or stone must be taken down to roof level.

External conditions

As already stated, a chimney outlet should be well above adjoining trees and buildings, and a chimney emerging from the roof slope or near the eaves should be built up well above the level of the ridge.

The atmosphere for 2 or 3 ft. above the roof surface is disturbed when the wind is blowing. On the side against which the wind is blowing an area of pressure is created and on the opposite side an area of suction. These will, of course, be reversed when the wind blows in the opposite direction. Taller adjoining buildings and trees create similar area of pressure and suction. If the chimney outlet is too low, and therefore within the area of high pressure, the smoke may be driven back down the chimney. Hence the importance of having the chimney outlet high enough to be clear of the disturbed atmospheric area.

Anti-down-draught pots

If there are obvious faults in the fireplace or in the air supply to the fireplace it is better to remedy them than to have an anti-down-draught pot or cowl fitted to the chimney. But in most cases the addition of such a pot is the cheapest treatment.

In cases where the cause of down-draught is a chimney outlet at too low a level it is better to build up the chimney than to fit a special pot. If a special pot is fitted in such a case it will probably cure the down-draught by adding height to the chimney outlet—not by any special properties of design. In fact a "tallboy" pot, which is merely a tall pot, will have the same effect.

Where the area of atmospheric disturbance is very high, owing to tall trees or buildings nearby, the anti-down-draught pot is the only hope. These pots are designed to convert the abnormally high atmospheric pressure into an upward force. Choose a reputable make and one of the neater designs. These pots are obtainable in burnt clay and also in asbestos-cement.

Revolving cowls are ugly, but may be the only remedy in bad cases. The smoke outlet is always turned away from the wind, so that the wind creates suction in the outlet irrespective of the direction from which it is blowing.

Flues for independent boilers

These boilers and stoves are self-contained, and brick fireplaces are not needed, though the stoves must stand on a hearth or floor of fireproof material and there should be no woodwork close to them.

Flues may be of cast iron, taken through an outer wall and supported by clip holdfasts built into the wall. But brick flues are, of course, better, as cast iron rusts away in time. Brick flues

should be constructed with an extension below the inlet from the stove and a cleaning door should be fitted into this extension. This allows soot falling down the chimney to accumulate in the extension, from which it may be removed through the cleaning door. If this extension and cleaning door are omitted the flue is liable to become choked at the junction of the bend and brick flue (see Fig. 4).

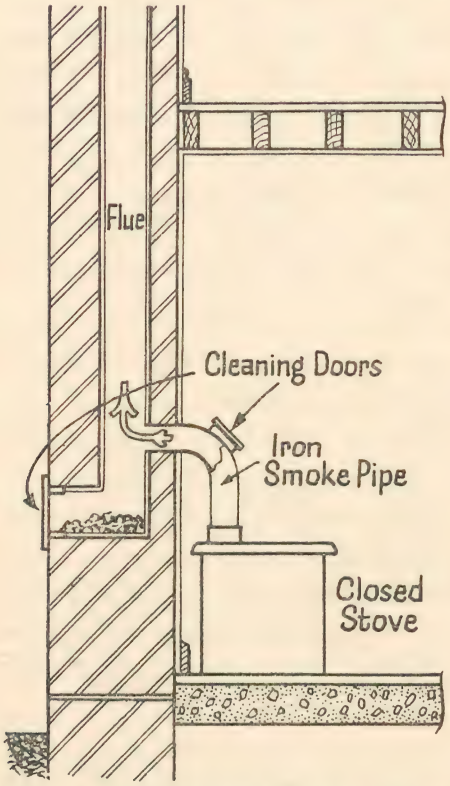


FIG. 4. AN INDEPENDENT BOILER WITH AN IRON FLUE PIPE BEND CONNECTED TO A BRICK CHIMNEY FLUE
Notice the cleaning doors

Cast-iron flues should be painted with a special heat-resisting paint. It is useless to apply an ordinary black paint. It is particularly important to paint the clips and holdfasts, as if these rust the flue pipes may collapse.

A common fault with cast-iron flues is to have the outlet just above the eaves. Down-draught may result owing to the outlet being within the area of high pressure. The same principles apply to draught in a cast-iron flue as in a brick one.

Gas fire flues

A gas fire need not be set back between chimney breasts. The outlet for fumes is at the back and should be connected to a flue. The flue size need not be more than 9 in. by 4 in., and flue blocks of this size are made of pre-cast concrete for building into brickwork walls—thus economizing space. If gas fires are fitted in an existing building, flues of asbestos-cement should be used. Cowls and anti-down-draught baffles are made of the same material. These flue pipes can be taken through the roof if desired.

It is important to avoid bad down-draught in gas flues, as this would be dangerous, especially in the case of gas geysers.

CHAPTER XIII

WINDOWS

Windows serve three functions: to admit daylight, to allow the outside scene to be viewed and to allow ventilation (both inlet and outlet).

The tendency in modern design is to have wide windows, even to the full width of the wall, so that the daylight is spread across the room. If you have two or more narrow windows instead of one wide one, the wall areas between the windows cast shadows.

A better view is obtained through a wide window, especially if it has large glass panes instead of many small ones. This brings us to another tendency in modern design—to reduce or eliminate the dividing mullions and glazing bars, thus giving an unobstructed view.

There are at least four types of opening windows used in houses: the side hung casement; the top hung casement; the vertical sash with counterweights; the sliding, and sliding and folding, casement.

A combination of side hung casements with top hung transom casements is favoured in modern design. Structurally such windows are simple, there is very little to get out of order and it is easy to construct wide windows.

The sash window with counterweights on cords or chains is very good for ventilation, but it is essentially a vertical type, better suited to tall and rather narrow rooms than to wide ones of moderate headroom.

For good outlet ventilation an opening window should have the head not much more than 12 in. from the ceiling. With the normal floor to ceiling height of 8 ft. this allows outlet ventilation well above the head level of a person standing in the room.

For unobstructed vision it is important to have the transom (if there is one) just above eye level taken from a standing position. A transom 5 ft. 9 in. from the floor is about right.

Construction of wood casements

A fixed casement, no part of it opening, consists of a rebated frame. The glass is puttied into the rebate. But most windows have about half the area to open. The opening casement is essentially a double frame—the opening frame being hinged to the fixed frame.

The first problem we meet is to make a weathertight fitting

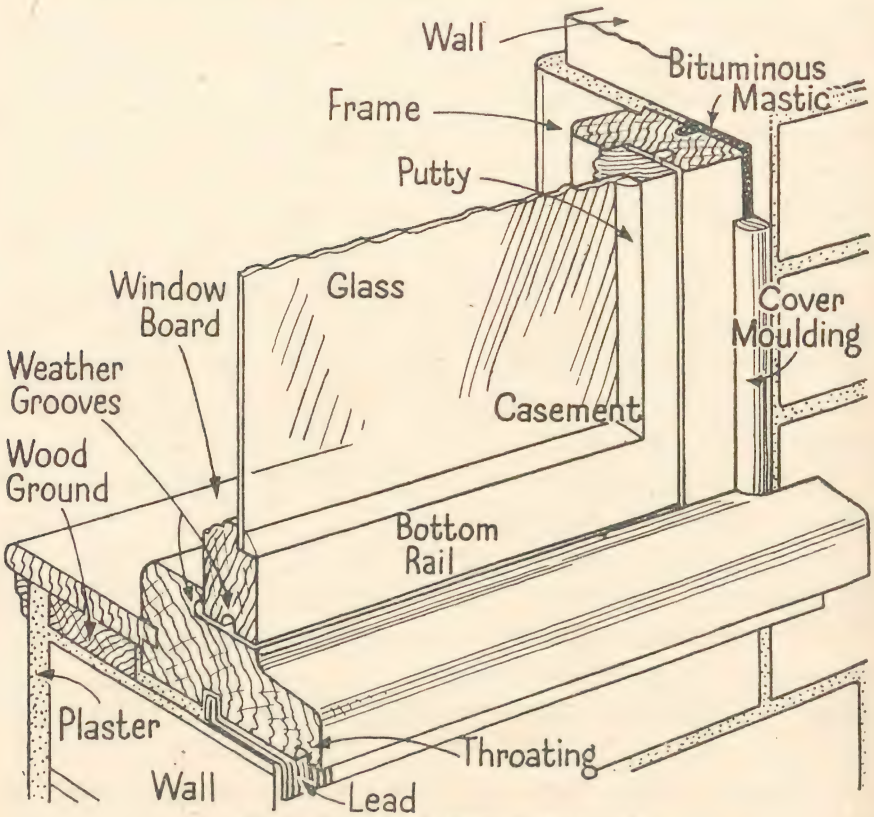


FIG. 1. A WOOD CASEMENT WINDOW

The frame is made weathertight against the wall with bituminous mastic, and under the sill with a a lead apron flashing

between the opening and the fixed frame. Capillary movement aided by wind pressure will soon drive rainwater through the narrow gap between the two frames. So it is usual to groove the frames, and sometimes the opening casement, too, where they meet. Rainwater entering the gap cannot creep across the groove and will run down to the sill.

The sill is a very exposed part as rainwater streaming down the window tends to collect here and will find its way through

any gap. It is usual, therefore, to give the sill a weathered top—that is, to slope it outwards so that water is rapidly drained from it. There are two sills to a window: the sill belonging to the window frame and the sill belonging to the wall. In modern houses the wall sill is often constructed of brick-on-edge. This is quite good provided it is given a slight outward slope, but very often it is made level and water collects on it.

Perhaps the best method is to have the window close to the front of the wall with a wood sill which projects in front of the wall face and has a groove called a "throating" underneath, which allows the water to drip off instead of streaming down the wall.

In some houses condensation on the interior of the window is a common trouble—the condensed moisture streaming down the glass and collecting on the inside sill. If the sill has a groove which is drained to the outside by two small holes drilled to slope outwards, the water cannot collect here.

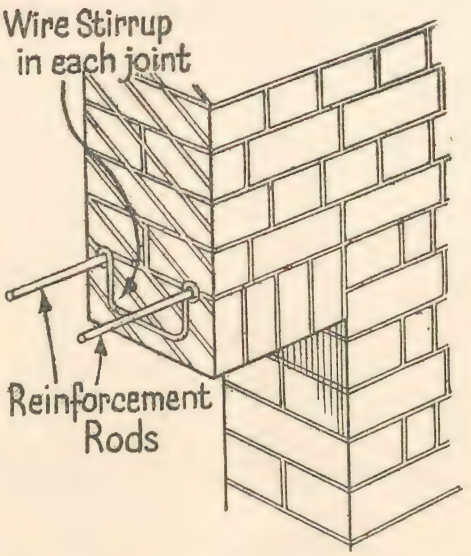


FIG. 2. A REINFORCED BRICKWORK LINTEL USED OVER WINDOWS AND DOORS

Window frames are jointed with mortice and tenon joints. The ends of the sill and head project and are usually left on so that they can be built into the wall, though the projections, or "horns," as they are called, at the head are usually cut back so that they are concealed behind the face of the wall.

Window heads are not meant to carry the weight of the wall above. A common method is to have a lintel at the back, which carries most of the load, and a brick-on-edge course resting on the head of the frame, so that some of the load is taken by the window frame, but this is not excessive.

Pointing round window frames

There is bound to be a slight gap between the window frame and the wall jamb. It is usual to cover this with a small moulding

which is nailed on after the window has been built in. But even this does not completely close the gap and rain can find its way in. This may cause the frame to rot and damp patches to

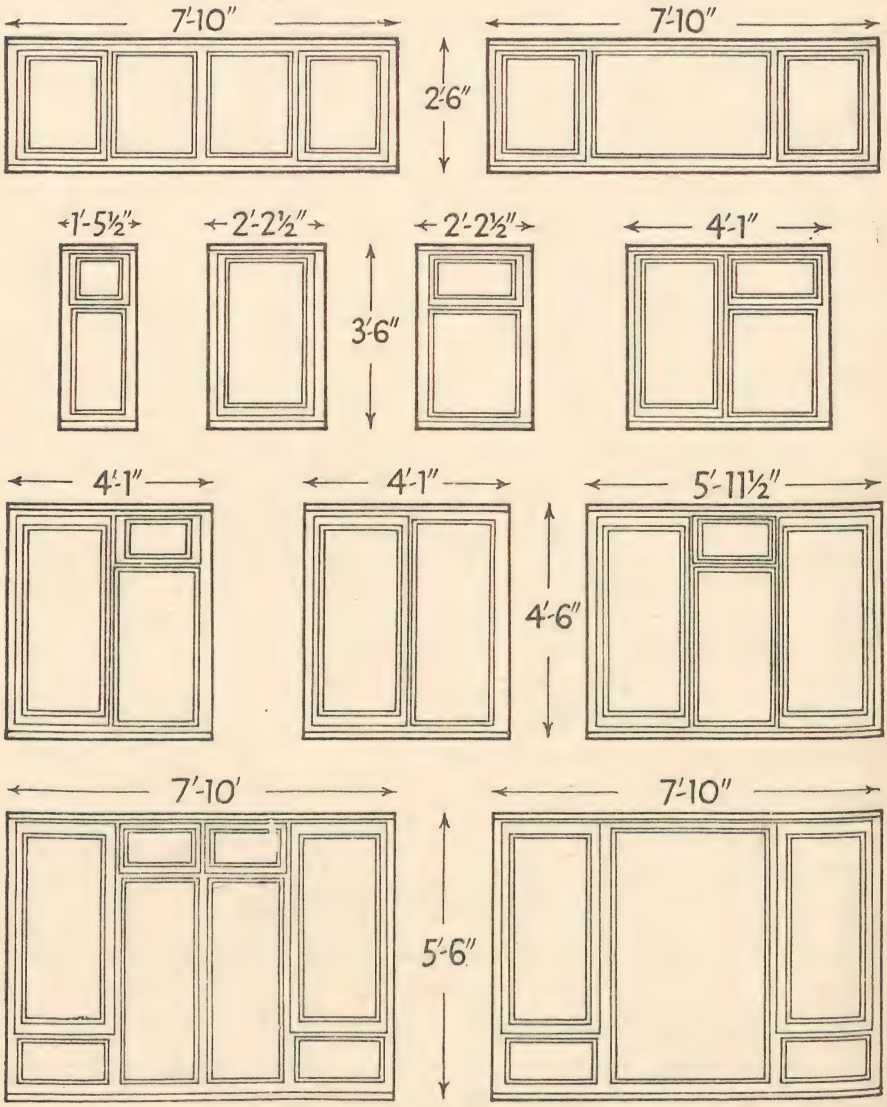


FIG. 3. A FEW OF THE WOOD CASEMENT WINDOWS STANDARDIZED BY THE ENGLISH JOINERY MANUFACTURERS ASSOCIATION

appear inside. Sometimes the gap is filled with mortar, but this is useless as the slightest shrinkage of the frame will cause the mortar to pull away.

The best treatment is to point the gap with a bituminous mastic, a material which has already been mentioned. This

retains some ductility and adheres well to both wall jamb and window frame, adjusting itself to expansion and contraction of the gap. It is quite an easy matter to point existing frames

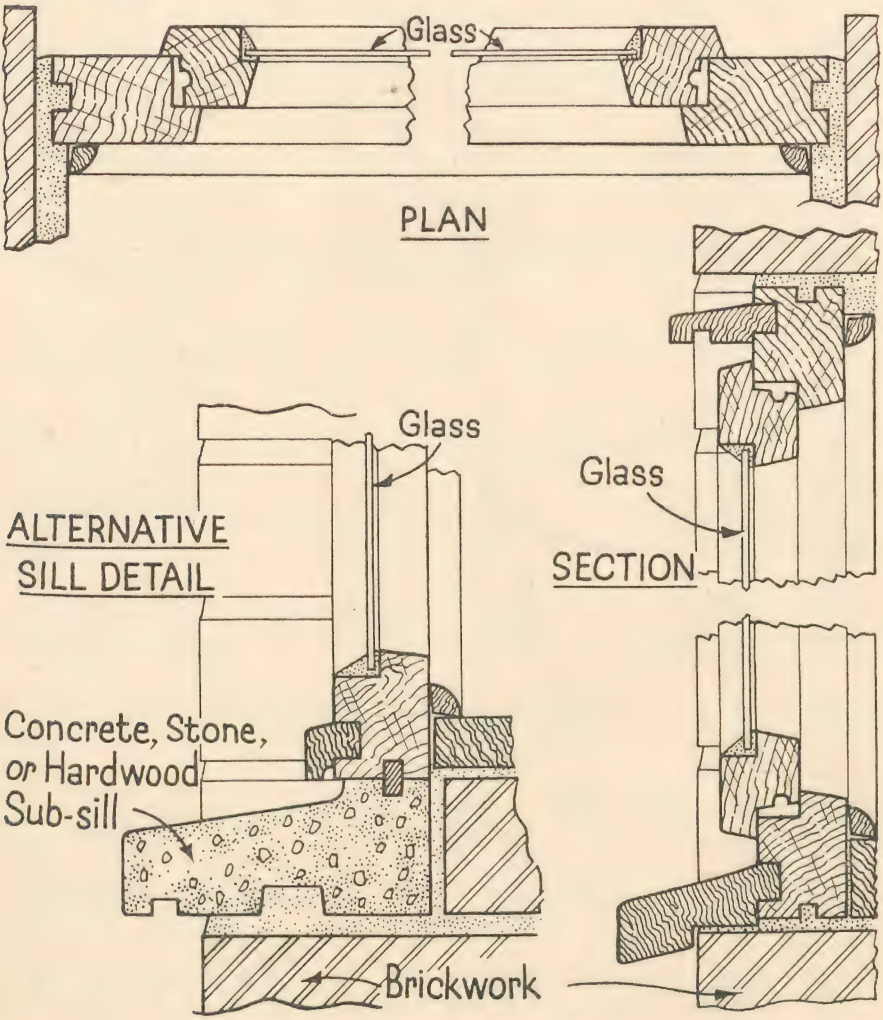


FIG. 4. DETAILS OF E.J.M.A. STANDARD WOOD CASEMENT WINDOWS

with this material, but the small planted moulding should be removed first and afterwards replaced.

The wood sill is sometimes made weathertight to the wall sill with a metal weather bar set in mortar or mastic, and sometimes by a strip of lead, the back edge being turned into a groove under the wood sill and the front edge turned down over the wall, as in Fig. 1.

Standard wood windows

A range of standard wood windows of the casement type has been designed by the English Joinery Manufacturers Association (these are called "EJMA" windows). They have been designed

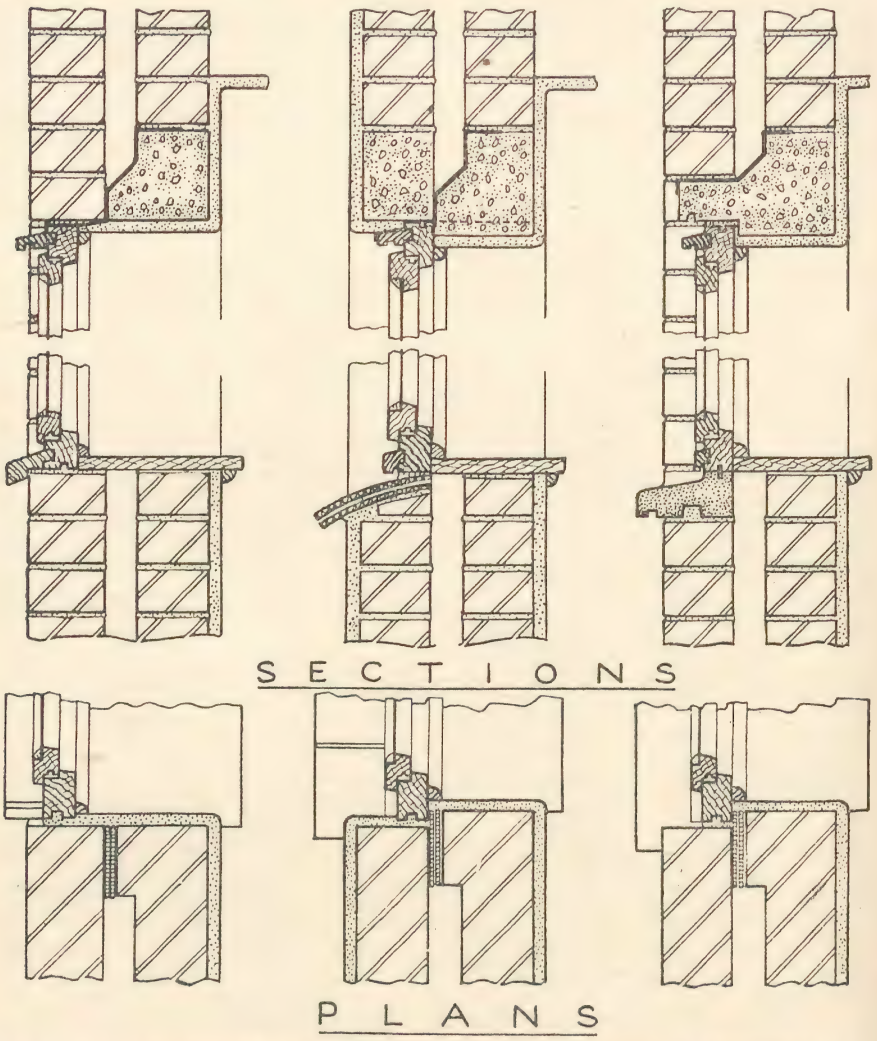


FIG. 5. WOOD WINDOWS IN CAVITY WALLS SHOWING VARIOUS TREATMENTS AT HEAD, SILL, AND JAMB

on the basis of special research and they differ from the windows hitherto generally adopted. The sections employed are lighter but the strength is adequate. As the sections of mullions, etc., are narrower they do not stop so much light as the older types of frame. From the weathertight point of view the design is excellent, certainly much better than the average window of the older type.

The range of sizes and patterns is generous and the casements can be combined to make larger windows and also used in conjunction with corner sections to make bay windows. Fig. 3 illustrates a few types of the range, and Fig. 4 typical details. The windows are made by all firms who are members of the Association.

It is recommended that these windows should be used with the sills at the following levels:—

Living-rooms and parlours—1 ft. 9 in–2 ft. 9 in.
Dining-rooms—1 ft. 9 in.–2 ft. 9 in.
Kitchens and sculleries—3 ft. 3 in.–3 ft. 9 in.
Bedrooms— 2 ft. 9 in.–3 ft. 3 in.
Bathrooms and w.c.'s—3 ft. 3 in–3 ft. 9 in.
Corridors and storerooms—3 ft. 3 in.–4 ft. 9 in.

There is also a standard range of casement doors, or French windows, with and without side lights and transom lights.

Standard metal casement windows

For many years there has been a range of steel casements standardized by the Metal Window Manufacturers' Association. A metal window consists of a fixed metal frame, and hinged casements where these are required.

Metal windows may be fixed direct into wall openings, but it is usual to fix them to either a wood surround or a wood frame. The wood surround is simply a frame of wood around the outer edges, while the wood frame includes mullions of wood with each metal window separate.

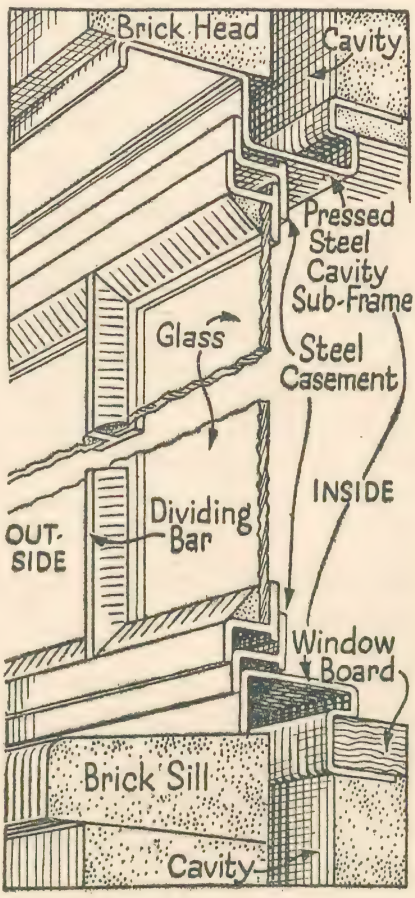


FIG. 6. A STEEL CASEMENT WINDOW IN A CAVITY WALL WITH A PRESSED STEEL SUB-FRAME

With metal windows in wood surrounds and without dividing bars there is minimum loss of light and maximum vision. The advantage of metal is, of course, that it cannot rot, warp or shrink. Earlier steel casements have given trouble through rusting, but standard casements are now rustproofed by galvanizing or other process.

Individual metal casements can be combined by using mullion and transom sections to make large windows. There are also

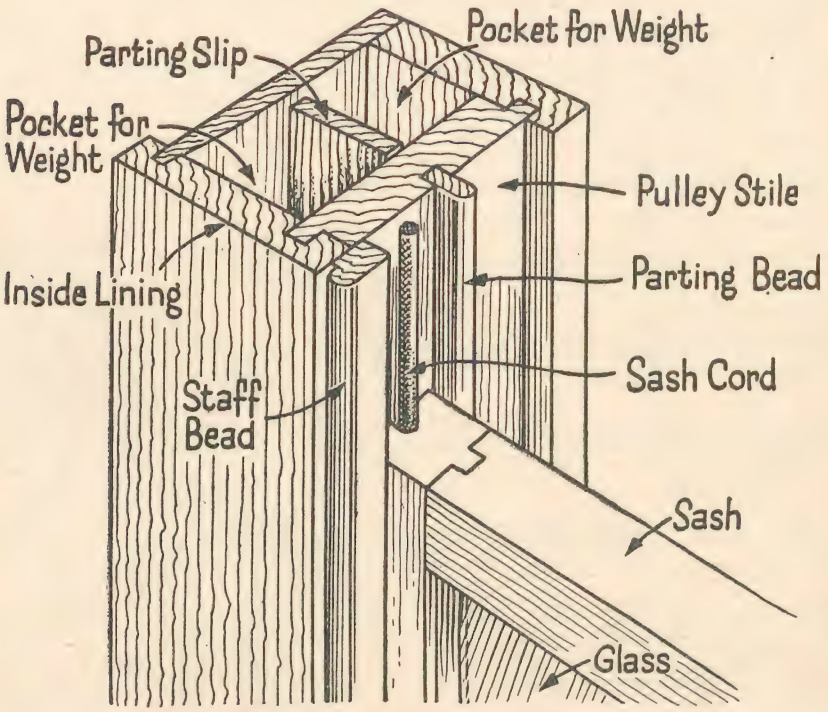


FIG. 7. BOX FRAME FOR VERTICAL SASH WINDOW
The weights and sash cords are accommodated in the frame pockets

standard metal casement doors and bay windows, including bays with rounded ends.

Vertical sash windows

These windows consist of a fixed box frame with sashes which slide up and down. The sashes are suspended by cords (or chains) running over pulleys and having counter-weights at the ends. These counter-weights run up and down the interior of the box frame.

As already mentioned, these windows are excellent for ventilation. The opening can be easily adjusted, and with top and

bottom opening we get inlet and outlet ventilation. Moreover, the open window does not project as the casement window does.

The weak point with the sash window is the cords or chains from which the sashes are suspended. If they break suddenly the sash will fall, but it is very rare that both sides give way at once. In fact as soon as there is sign of weakness in one cord both should be taken out and new cords fitted. Better still, renew all four cords.

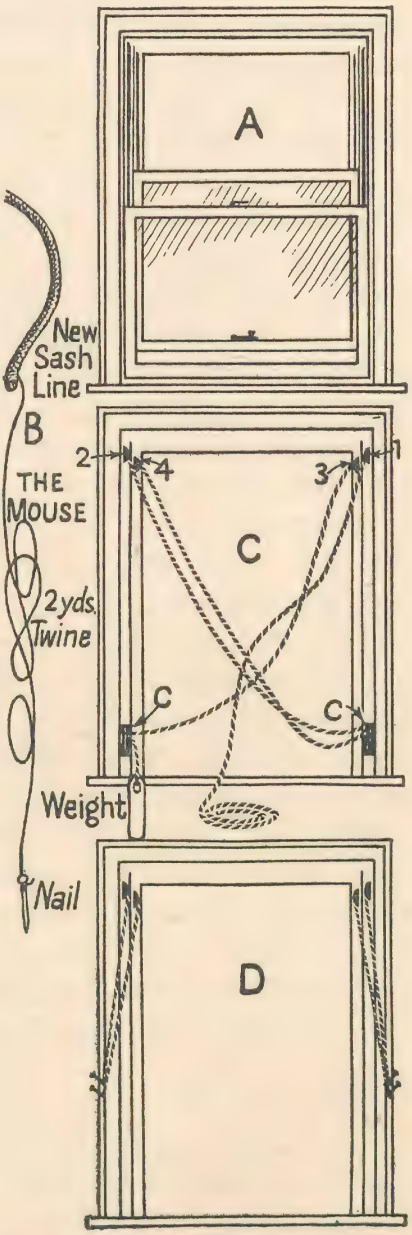


FIG. 8. METHOD OF FIXING NEW SASH CORDS

Fitting new sash cords

Of the several methods in use, the following, suggested by James Austin & Sons, Ltd., cord manufacturers, is one of the easiest. The description should be followed by reference to Fig. 8.

Fig. (A). Lower top sash and cut unbroken sash line. Gently ease out beading with chisel at the middle, and then at the other nails. When sufficiently loose, grasp firmly with the hand in the middle and pull out. Remove both sides, and the lower sash will come out. Proceed with the next beading in the same way (this should not have any nails in it), and remove the top sash. Take out the old sash line, clean up sash and put on one side.

Fig. (B). With a sharp knife cut an inch off the frayed end of the sash line and tie the loose end of the mouse in a slip knot round it (the "mouse" is a nail tied to 2 yd. of strong twine and

its purpose is to assist the operation of threading the sash cord).

Fig. (C). Ease out covering of side boxes c, and remove sash weights. Repeat cleaning, etc., as before. Loosen about 24 yd. of new sash line and stretch it to its utmost capacity by tethering one end to a post and the other end round the body, throwing all weight on to it. Push the mouse over pulley No. 1, and when it appears below at the opening of the box, pull gently until the sash line is safely through, and carry on to pulleys 2, 3 and 4. Remove mouse at end and put line through sash weight. Fix with a knot and place in the box. Draw weight up to the top and hang on with all your weight to settle the knot and again stretch your line. This will be the left line of the top sash. Proceed in the order given: 1, 2, 3, 4.

Fig. (D). Measure each line to about three-quarters of the length of the whole window, and place a nail through the line in the crevice of any fancy work round the window; then cut the lines. After this, place the line in the groove of the sash and fix with three clout nails. Replace each part in the opposite order to taking down.

It will be understood that the cord lengths must be such as to allow the sashes to slide up and down without the weights touching sill or pulleys, and that the counter-weights should be about the same as the weight of the sash (that is, if two counter-weights support a sash each should be half the weight of the sash).

The sash will not run smoothly if the pulleys are in poor condition. They need oiling occasionally, and if they are defective they should be taken out and replaced with new. Defective pulleys wear the cords.

Rustless sash chains can be used in place of cords if desired.

Window fittings

It pays to have the best fittings as they are moving parts which must sustain considerable wear. Casement stays are of two main types: the old type stay and pin, the bar having holes so that it can be used to hold the window open by slipping it over a pin screwed to the sill; and the modern sliding or friction stay which can be secured in any part of the open position by tightening a thumb-screw.

Casement fasteners should be strong and correct fitting of the

plate is important. They should be fixed so that the edge engaging with the fastener is sloped to ensure a wedge action as the fastener is engaged. This pulls the casement tightly against the frame. Casement stays and fasteners should be preferably of bronze. If of iron they should be rustproofed so that any defects in painting cannot result in rusting.

Hinges, stays and fasteners should be oiled regularly. Few people take the trouble to do this, yet the few moving parts of a house need oil just as a machine does.

"Easy clean" hinges are made for both wood and metal casements. These project, and when the window is open enable the hand to be passed through the gap on the hinge side, and thus the outside of the open window and the closed portion next to it are accessible for cleaning from inside the room. This is very useful in bedrooms and enables the services of a window cleaner to be dispensed with.

Glass

Windows are normally glazed with 24 oz. drawn sheet glass, approximately $\frac{1}{10}$ in. thick, though 18 oz. is often used for small panes. The weight is per sq. ft. Drawn sheet is very slightly uneven so that distortion of view is inevitable. But there are three qualities: "ordinary glazing," "selected glazing" and "special selected." If the latter is used distortion is very slight.

Where there is a good view from a window it is an advantage to have a very large pane, and for this purpose polished plate glass is much better than drawn sheet as it is not only stronger but gives undistorted view. Here, too, there are three qualities. The lowest known as "general glazing quality" is good enough. The normal thickness of plate glass is $\frac{1}{4}$ in., but for panes of ordinary size the $\frac{1}{8}$-in. thickness is enough.

There are various rolled glasses which are useful when it is desired to obscure the view. Those with deeply impressed patterns are difficult to clean, but the "Cathedral" type is not deeply impressed and is fairly easy to clean. For semi-obscuration the "Rough Cast" type is suitable.

Wired cast glass should be used where breakage would be dangerous, and also where high fire-resistance is required. Wired glass should be used in the glazed roofs of sun porches,

verandahs, etc. A better looking pattern than the ordinary hexagonal wire mesh is the "Georgian" wired which has a square mesh.

There are special glasses which deserve to be better known. Everyone has heard of the "Vita" glass, which admits ultra-violet rays, provided it is kept perfectly clean. There are also toughened glasses useful for shelves and table tops, and heat-absorbing glasses of greenish-blue tint which absorb about 80 per cent. of the sun's heat, and so would be useful for a larder window which faces the sun. There is even a glass which discourages flies and insects—it is amber tinted, and apparently flies are alergic to amber light.

If you have an old house with the original glass windows, this is probably the kind known as "Crown" glass. A "New Crown" glass is made in sizes up to 18 in. by 12 in. for replacements.

Glazing

Glass can be fixed by holding the edge between wood—as in a rebated edge with a wood bead. When this method is used the edge of the glass should have a strip of washleather bent round it.

Glazing to wood frames is done with ordinary putty, which is a mixture of raw linseed oil, powdered whiting and a little turpentine. It does not pay to mix it from bought ingredients as it is obtainable anywhere at a low cost.

When glazing, work a little putty on to the back of the frame rebate, spread it with the knife and then press the pane of glass on to it. This back-puttying is necessary to make the glazing watertight. The pane should then be secured by metal sprigs. The putty can then be applied and finished with the knife. When the putty has set it should be painted. Without paint it dries too much and shrinks. But if it is painted while still very soft it will take a very long time to set.

For glazing to metal frames ordinary putty should not be used. Use a special proprietary metallic putty, of which there are several good brands.

For glazing direct to stone and concrete mullions, etc., use a mortar consisting of equal parts of Portland cement and sand.

Leaded lights

The modern tendency to admit as much light as possible, to obtain a clear view and to reduce the labour of cleaning has put leaded lights out of fashion. We prefer the large pane. Many old houses have leaded lights, and these need periodical attention. Any small leaks should be stopped with metallic putty. Bending is a common defect, especially with large areas. Copper saddle bars should be fixed in the casement at the back to strengthen the light, and the lead "cames" should be wired to the saddle bar.

To flatten bulging leaded lights use a square piece of wood wrapped in cloth, while a helper holds a straight piece of wood firmly against the opposite side. If the cames are bent at the edges press them back with a piece of wood—the opposite side being supported by a helper. To remove a broken pane cut the corners of the lead came so that the lead edges can be turned outwards, as shown in Fig. 9.

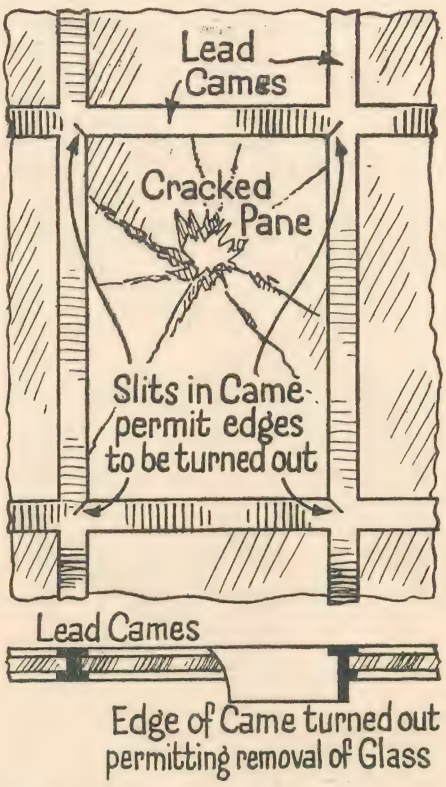

Lead Cames
Cracked Pane
Slits in Came permit edges to be turned out
Lead Cames
Edge of Came turned out permitting removal of Glass

FIG. 9. LEADED LIGHTS—HOW TO REMOVE BROKEN GLASS

Glass cutting

It is advisable to have glass cut to size at the merchant's shop. You can either take the measurements or cut out a brown paper templet, but allow a clearance all round. If the glass is a tight fit at the edges any shrinkage of the frame may crack it. Though diamond cutters are best, a good steel wheel cutter is efficient, but glass cutting can only be easily done after much practise. A firm movement is required, but not great pressure. A large pane should be broken by placing the cut line over the edge of a board or bench and applying pressure.

Glass bricks

These bricks or blocks are hollow and of moderate weight. The edges are sanded and the bricks are laid in ordinary mortar, but the built-up panels must not be too large. Panels should be jointed along the outer edges in a special mastic.

Glass bricks are useful where light but no view or ventilation is required. The thermal and sound insulation is much better than that provided by ordinary windows, and, of course, the bricks are not easily broken. Glass brick panels can be built into the walls on each side of an entrance doorway, in a larder or built-in cupboard, and in verandah walls.

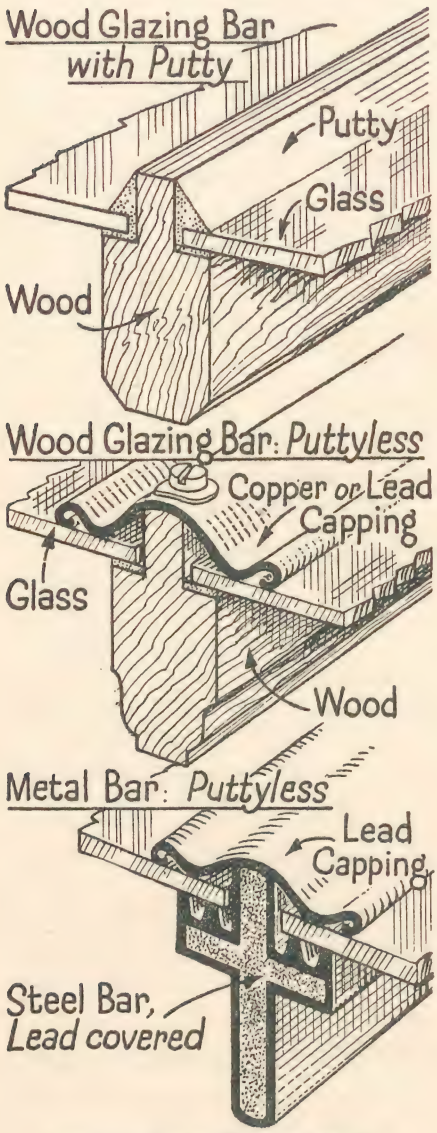


FIG. 10. ROOF GLAZING BARS

Roof glazing

In new work it is advisable to use puttyless glazing bars, which may be of wood or protected metal. Instead of putty, the glass rests upon asbestos cords and is secured and covered at the edges by a cover of lead, copper or zinc, as in Fig. 10. The bars should be fitted with clips at the ends to prevent the glass sliding down.

In the old type of putty bar leakage may occur by shrinkage of the putty and by warping or sagging of the bars. If these defects are general it is advisable to remove the old putty, take the glass out, chip the old putty clean away from the bars and reglaze. If the bars have sagged purlin timbers should be placed underneath to support them.

Glass roofs abutting against a main wall should have a metal flashing to make the roof weathertight against the wall. Leakage

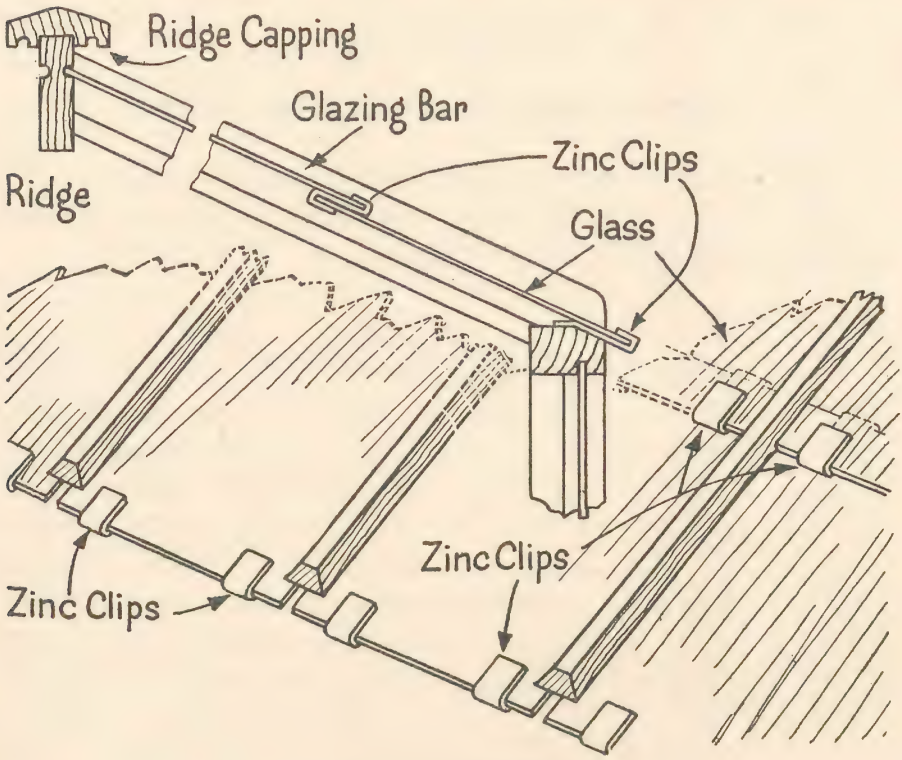


FIG. 11. ROOF GLAZING
Showing use of clips to prevent glass sliding downwards

may come from a defective flashing. If the defect is slight it can be repaired with mastic.

If glass tends to slip down the bars, one or two zinc clips fixed at the bottom edge will secure it, as shown in Fig. 11.

CHAPTER XIV

DOORS AND INTERIOR JOINERY

With ordinary use doors and interior joinery will last for generations, provided that rot is guarded against and that little defects are attended to without delay.

Doors

The simplest type of door consists of several vertical boards nailed on to two or three horizontal ledges at the back. This is hung to a frame with T or strap hinges. A little consideration will show that such a door tends to sag at the opening edge. To prevent sagging diagonal braces can be nailed between the ledges as in Fig. 1. The braces should be a tight fit, and it is better to notch them into the ledges. The bottom of the brace should be on the hinged side of the door, so that the brace will be in compression.

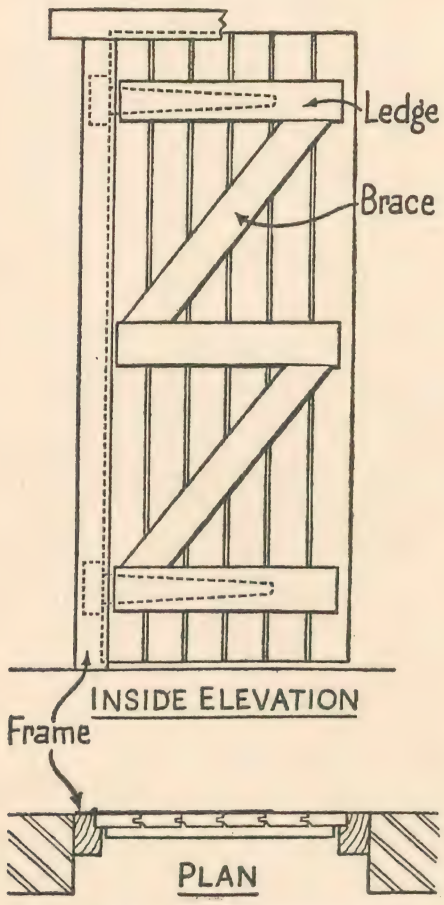


FIG. 1. LEDGED AND BRACED DOOR

A ledged and braced boarded door, the boards being grooved, tongued and beaded, is quite a sound job, though if the wood shrinks badly the board joints may open. The best remedy for this is to take the boards off and renail them, cramping them tightly together, or vertical strips can be nailed over the open joints. A temporary repair can be made with putty.

A panelled door consists of pieces of wide board framed in comparatively narrow thick lengths. The framing is jointed with mortice and tenon joints, and the panels fit into grooves, as shown in Fig. 3. These joints allow for slight shrinkage, though excessive shrinkage will open them.

Entrance and back doors, and casement doors, are thicker

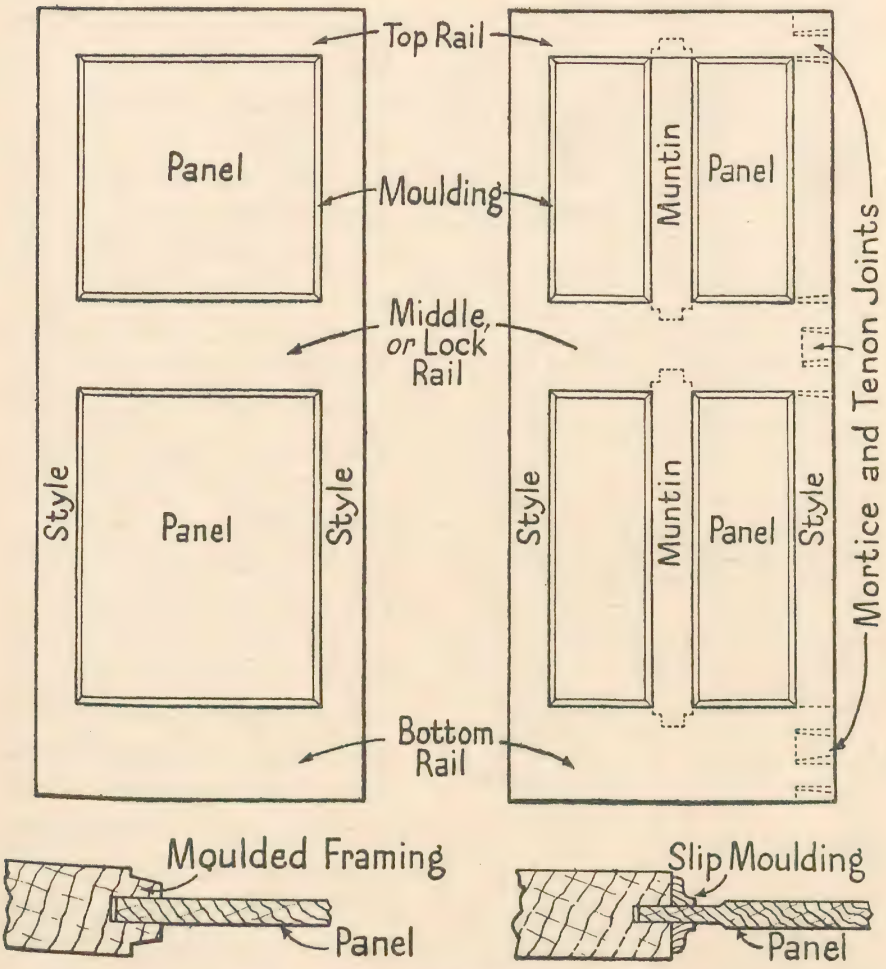


FIG. 2. FRAMED AND PANELLED DOORS

than interior doors and are made to stand the weather. There are standard ranges of doors for houses, and joints and sizes are the subject of a British Standard Specification to which all reputable manufacturers conform.

Flush doors are increasingly used for interiors. The construction consists of a supporting core on which is glued under pressure

a veneered plywood sheet on each side. These doors are easily cleaned and the flush surface is in harmony with the simple shapes of modern design.

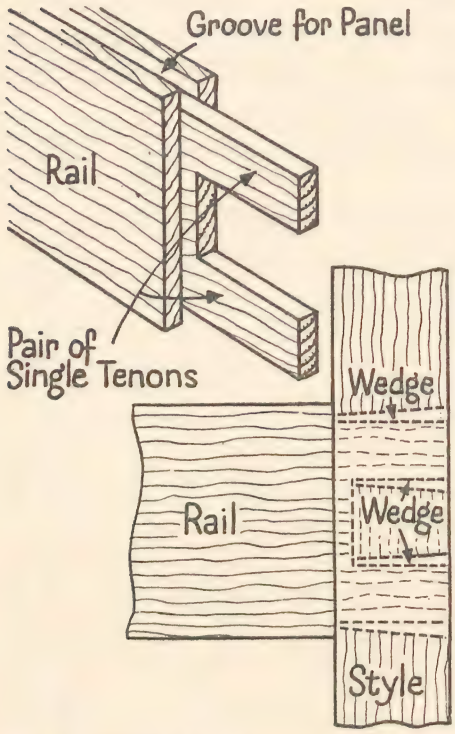


FIG. 3. MORTICE AND TENON JOINT USED IN JOINING DOOR RAIL TO STYLE

Repairing doors

Wide panels sometimes split through shrinkage. The best treatment is to cut a sheet of thin plywood, bevel the edges and fix it over the panel with panel pins. With an outside door it is advisable to glue the edges with a waterproof resin glue. Slight cracks can be filled with plastic wood which, of course, should be painted over, but plastic wood shrinks slightly and is not suitable for wide cracks.

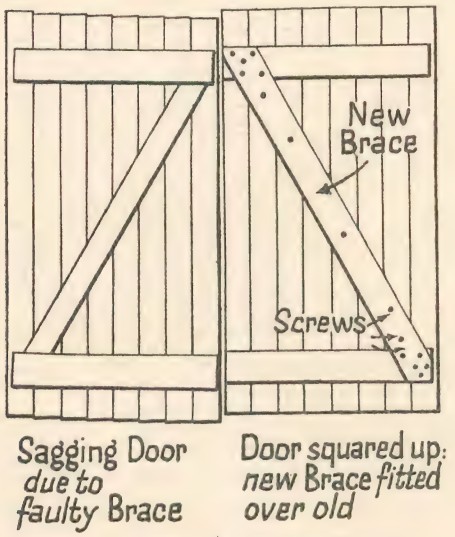


FIG. 4. HOW TO REPAIR SAGGING BOARDED DOORS

If the painting of an outside door has been neglected water may penetrate the mortice and tenon joints and the rails may pull away from the stiles. Take the door off and knock the stiles tightly up to the rail ends, then drive the wedges into the mortices if they have become loose. It is better to place the door in two or three cramps than to tighten it by using a mallet. If the joints are very loose it is advisable to take it to pieces and glue it up again, using a waterproof glue. It should then be put in cramps and left on a flat surface until the glue has set.

Garage doors sometimes sag, especially if the joints become loose. Take the doors off and restore them to the square. Then fix braces at the back, screwing them on. If they are already braced fix long braces from corner to corner over the old ones as in Fig. 4.

Frames and linings

Outer doors are hung to frames. An ordinary back door and entrance door has a frame about 4 in. by 3 in. The inside edge is rebated to take the edge of the door. The frame is morticed and tenoned at the top and the head projects at each end so that it can be built into the wall. There should be a metal lug screwed to the side frames for building into the wall jamb, and the frame feet are secured by dowelling them to the step.

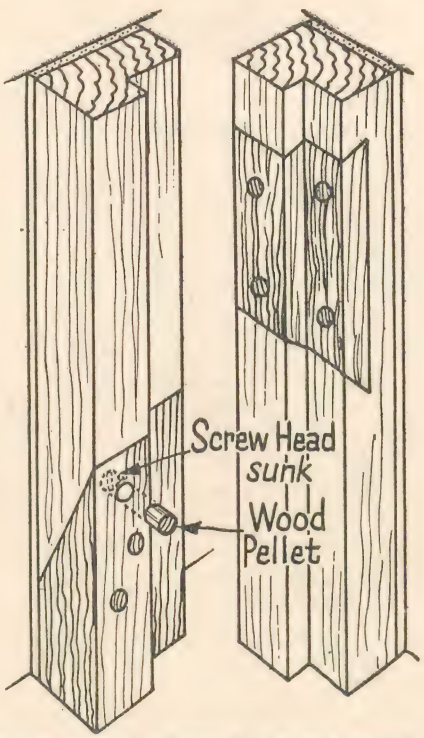


FIG. 5. HOW TO REPAIR DOOR FRAMES

Old frames may rot at the feet. The decayed portion can be cut off and a new piece fitted, as in Fig. 5, but it is better to take out the old frame and fit a new one.

The head of a garage door frame may sag if it is used to support the front part of the wall, or if the lintel is not stiff enough. The sagging will be accompanied by some settlement of the wall above, cracking the joints. If the sagging is slight it is advisable to plane the tops of the doors so that they will not bind, and leave it at that. But if it is bad and tends to increase a length of timber 7 in. or 8 in. deep should be screwed to the back of the door frame, as in Fig. 6, and the ends should be supported on new posts. This takes the weight of the wall above. Just before fixing this new timber put a prop under the middle of the frame and put a pair of folding wedges under it so that it can be tightened against the head. This will lift the

sagging head slightly. When the new beam piece is in position it can be screwed to the frame head to hold it, and the prop can then be removed. Any cracked joints in the wall above should be carefully pointed.

Interior door linings are about $1\frac{3}{4}$ in. thick or a little more. They are rebated to take the door edges, as shown in Fig. 7. They should be nailed to plugs or grounds in the wall jamb.

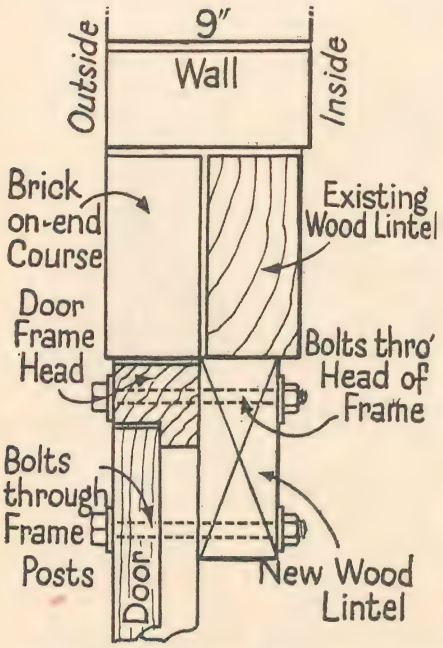


FIG. 6. HOW TO FIX A NEW LINTEL TO PREVENT SAGGING OVER A WIDE OPENING

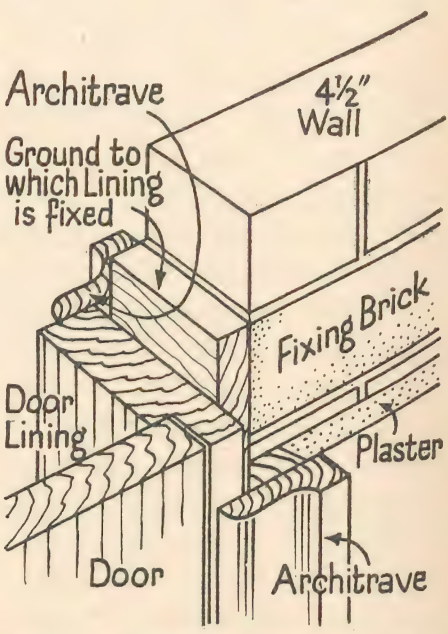


FIG. 7. HOW THE DOOR LINING IS FORMED TO AN INTERIOR DOORWAY

If a door lining is loose probably the wall plugs have shrunk. Short of removing the lining, effective treatment is difficult. The feet of the lining may be secured if the architrave (the moulding round the door opening) is first removed so that a packing piece of wood can be inserted just behind the foot of the lining. Then skew nail through the lining to the floorboards. This cannot be done if the floor is solid (tiles, concrete, etc.). Another way of securing the door lining is to find the position of the plug and then drive 4-in. nails through the middle of them. This will probably split the plug and expand it so that it grips the joint of the wall.

Making doors and frames weathertight

If water is penetrating a door or doorway, first examine the joints. If these are sound look to the joint between frame and wall jamb. Water may penetrate the slight gap here. The gap can be closed by pointing with mastic, as already described for windows on p. 158.

Water most frequently enters through the gap between the door and the frame, especially if the door or frame has warped. The only certain remedy is to fit a new door or frame, but you

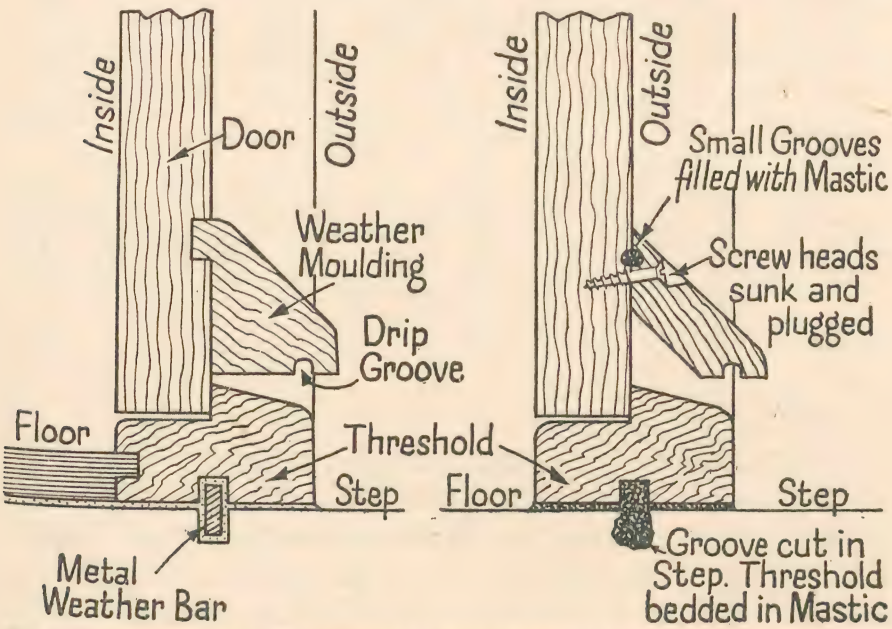


FIG. 8. RAINWATER CAN BE PREVENTED FROM ENTERING UNDER A DOOR BY FIXING A THRESHOLD AND WEATHER MOULDING

can try planing the door edges to make a better fit, or if the trouble is due to shrinkage you can cover the gap on the opening edge and the top by nailing a cover moulding or strip on the door so that it projects over the frame.

The bottom of the door is the most likely point for water to enter. Rain driven by strong wind may blow under. To stop this fit a threshold, preferably of oak, to the step, as in Fig. 8, and a weather board or moulding to the bottom rail of the door.

Water may enter through the joints of a matchboarded door if the boards have shrunk badly. To remedy this cover each vertical joint with a strip of wood, bedding it to the boards in thick paint.

In an exposed position it may be impossible to keep water out, even if door and frame are perfect. The only remedy then is to build a hood or porch outside. The hood already described on p. 30 may be sufficient, but in a really bad case an enclosed porch may be necessary.

Doors and Carpets

If you want a door to open over a carpet you must either cut about ½ in. off the bottom of the door or fit rising hinges. Rising hinges put rather a strain on the screw fixing to the lining. The rebated portion of the lining to which the hinge is screwed may not be thick enough to stand the strain. If the hinges pull out, remove the architrave and insert a hinge block at the back of the lining, then screw to this.

If the door catches only the margin of the carpet (where the carpet is not fitted close to the wall), it may be sufficient to fix the bottom hinge projecting forward about ½ in. This will lift the opening edge as the door is opened.

Door fittings

The best locks are of the mortice type, so-called because they are fitted into a mortice cut in the door. Obviously to enable this to be done the lock must be thinner than the door. Mortice locks are neater because the body of the lock is concealed, and stronger since the door would have to be broken to remove the lock.

Rim locks and latches of the cheapest types used to be fitted in many small houses, but the cheaper mortice locks are now preferred. A rim lock is screwed to the door and looks rather ugly unless it is of an ornamental type. Rim locks are rather easily forced off the door, and for this reason insurance companies do not favour them.

Bolts are so familiar that all we need say here is that the small cheap types should be avoided for outside doors. There should be a strong bolt top and bottom. With a good mortice lock this will make forcing the door a rather tough job.

With a solid floor or step a vertical bolt fixed to the bottom rail with a socket built into the step or floor will be very secure.

There is so much cheap and shoddy door furniture, as well

as locks, about that a warning is necessary. As these fittings contain moving parts which must take a lot of wear it pays to buy good quality. Cheap locks soon go wrong and cheap door furniture soon sheds the knobs. But something depends on fixing, too. The best fittings will not function unless they are fixed in exactly the right position. You may find some fittings which need moving by about $\frac{1}{8}$ in. to give proper working. The difficulty in moving them is the impossibility of making new screw-holes on the edge of the existing ones. This can be got over by filling the existing holes with plastic wood. When set new holes can be drilled without difficulty.

Staircases

The simplest kind of stairs are built on the step-ladder method. The ends of the treads are supported in housings cut in the strings. But in a staircase proper the space between treads is filled by risers. Fig. 9 will make these terms clear, and also the principles of construction. The housing to the strings is wedged to make a tight fixing and blocks are fixed underneath to stiffen the treads and risers. Treads and risers are grooved and tongued together, and the tread has a projecting nosing with a small moulding underneath. Some staircases, especially those wider than 3 ft., are provided with intermediate support in the form of a carriage with bracket pieces nailed to it to give support and stiffening to the treads and risers up the middle of the stairs.

The head and foot of each outer string is jointed to newel posts—these posts also serving to support the ends of the balustrade. In some cases it is necessary to carry the upstairs newels down to the ground floor for support. These are called storey posts. In other cases the upstairs newels are supported at the bottom by the staircase trimmer or trimming joists.

The "going" of a staircase should be easy, which means that the depth of the treads should be greater than the depth of the risers and the angle of the stairs less than 45 degrees. A 7-in. rise with a 9-in. tread makes a nice easy going, but in small houses a $7\frac{1}{2}$-in. rise to an 8-in. tread is more usual. The width of a small house staircase is usually about 2 ft. 9 in. A 3-ft. width not only looks better but is very useful when moving bulky furniture up or downstairs.

Winders are not desirable, though they are not dangerous if placed at the bottom of the stairs. It is, however, better to have straight flights with intermediate landings.

In design it is important to allow sufficient headroom when

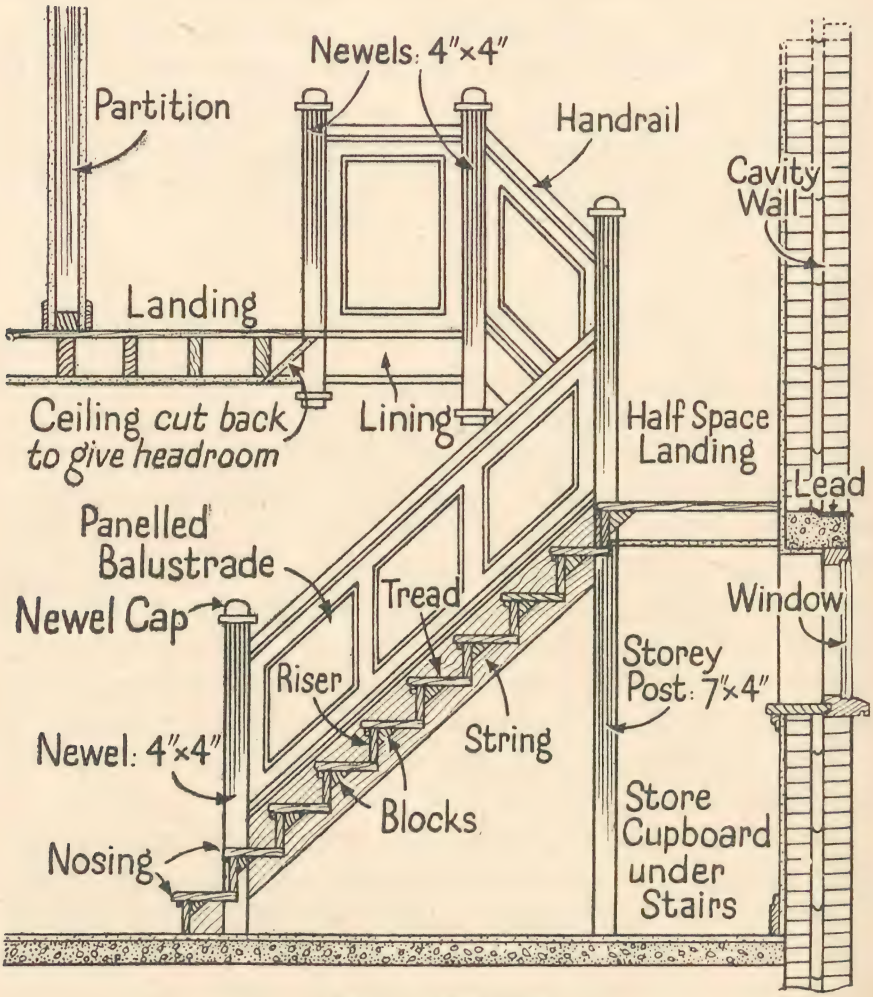


FIG. 9. A STAIRCASE
There are several types, but this one illustrates typical construction and technical terms

deciding the size of the stairwell. Generally, the stairwell in a small house should commence not further than directly over the edge of the fourth step. If upstairs space is restricted it is usual to build a bulkhead or a sloping ceiling to enable a partition to stand well over the stairs.

Another important point is the lighting of the staircase. Some halls are badly lit and the staircase depends chiefly on

light from the upstairs landing window, which may be small. Light coming down the stairs is not so good as light directed on to the stairs from the hall, the reason being that each tread casts a shadow on the one below when the light comes from the back. Good artificial lighting is also important. Falling downstairs

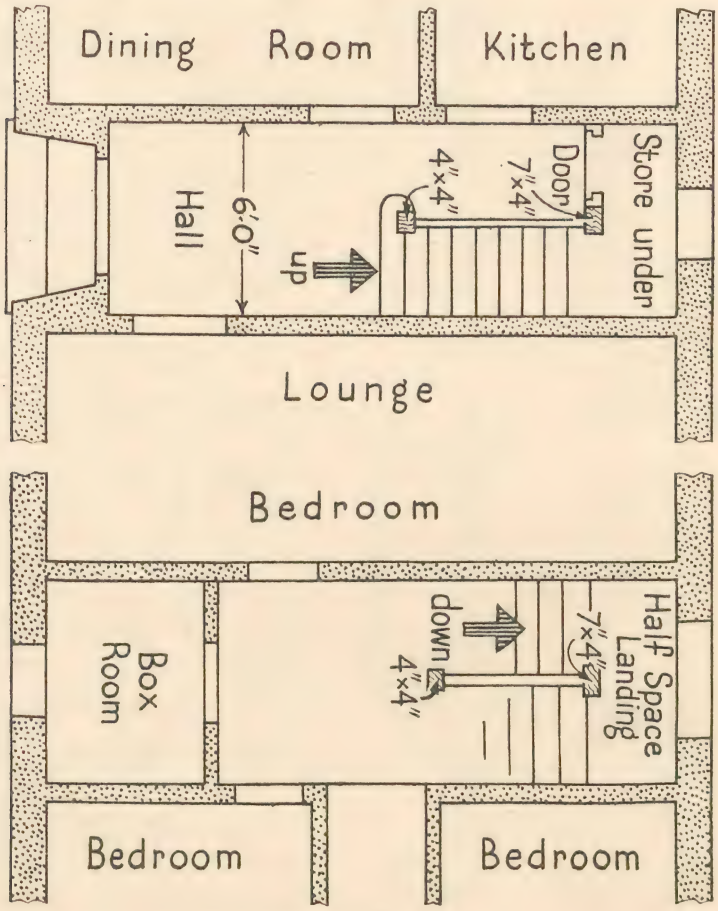


FIG. 10. PLAN OF THE STAIRCASE ILLUSTRATED IN FIG. 9
Ground floor on the left ; upstairs on the right

and slipping in the bath are the two most common domestic accidents, so in both cases good lighting should not be neglected.

Staircase defects

Loose and squeaking treads, loose handrails and newels and (in old houses) rotten woodwork are the chief faults. Squeaky treads are all too common, even in new houses. This is due to

inadequate support or to careless workmanship. Examine the wedges underneath which tighten the tread ends in the string housings. If a wedge is loose tap it in with a mallet. But squeaks usually arise from looseness in the tongued and grooved joint between treads and risers. The best treatment for this is to stiffen the angle with blocks, as in Fig. 11. These should be fixed by glueing and screwing. If the staircase is wider than 3 ft. and has no central carriage piece, add one, as shown in Fig. 11, with brackets attached which should make a good fit against the treads.

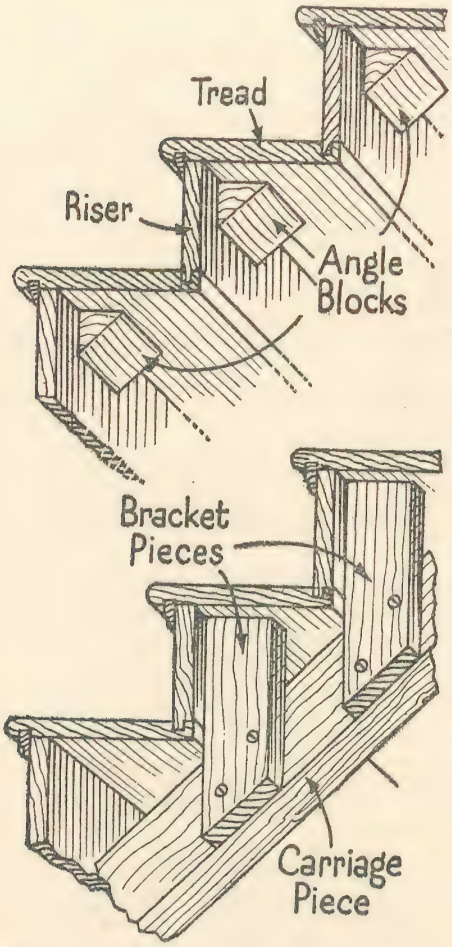


FIG. 11. TREADS AND RISERS ARE STRENGTHENED BY ANGLE BLOCKS AND BY BRACKETS FIXED TO A CARRIAGE JOIST

The balustrade consists of balusters supporting a handrail, which is usually in straight runs, the handrail ends being tenoned and pinned to the newel posts. In some stairs the handrails run over the newels and are wreathed. The balusters should be tenoned to the string capping and to the handrail.

Any general looseness of the balustrade should be treated by making the joints stronger. This may often be done by skew nailing. If the joint is open and loose work a little plastic wood or waterproof glue into it.

The space under the stairs is usually enclosed with a panelled spandril in which a door is included so that the space can be used for storage. Some ventilation is needed under the stairs, or if the door is kept closed for a long time dry rot may be set up in the woodwork. A few small holes drilled in the spandril will take care of this.

Wood trim

The skirtings, picture rail, door linings and a few other items of interior joinery are now often called "wood trim." Door linings in wood have already been dealt with.

Wood skirtings serve to protect the wall lining and to give a base line which adds to the appearance of the wall. Skirtings may be fixed direct to projecting wood plugs wedged into vertical joints in the wall, but in better class work wood grounds are first fixed to wall plugs and the skirting fixed to the grounds.

Picture rails are also usually fixed direct to plugs, though deep ones should be fixed to grounds.

Outside corners of skirtings and picture rails are mitred, but the internal corners have the end of one piece butting against the face of the other, the mouldings being scribed—that is one is cut to project and fit against the other. A mitred internal angle would open with the shrinkage of the wood. With the scribed angle the gap is less owing to the fact that the effect of shrinkage from one length only is observable.

Window boards cover the wall sill inside, and project over the plaster face, a moulding being usually fixed under the projection. The boards are tongued into the frame sill and secured to wood plugs projecting slightly from the wall sill.

Architraves are mouldings fixed round the windows and doorways (though in modern houses they are rarely used with windows). They, too, are fixed to plugs, except if very wide, when grounds are fixed to the wall first.

Wood trim defects

If the plaster face is not true uneven gaps will show at the back of skirtings and architraves. Or if the plugs or grounds stand out too much gaps will result when the wood is fixed (the plug or ground should finish just short of the plaster face).

Looseness may result from the shrinkage or rotting of wood plugs. This type of fixing is an old but poor one, and there are better methods. The best remedy is to remove the wood trim entirely and plug wood grounds to the wall, using patent fibre plugs. Then refix the wood trim.

Rot in skirtings is common in old houses. If the rot shows as a fungus with grey or brown strands and spore bodies it is a

sign of dry rot, which is probably also present in the floor (see Chapter XVII). The rotten skirtings should be taken out and

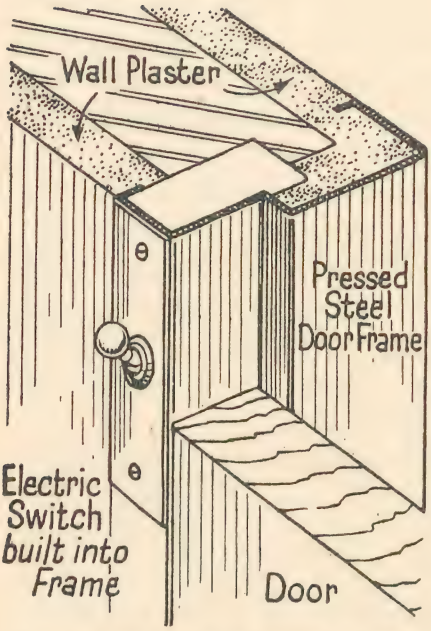


FIG. 12. PRESSED STEEL DOOR FRAME WITH BUILT-IN SWITCH

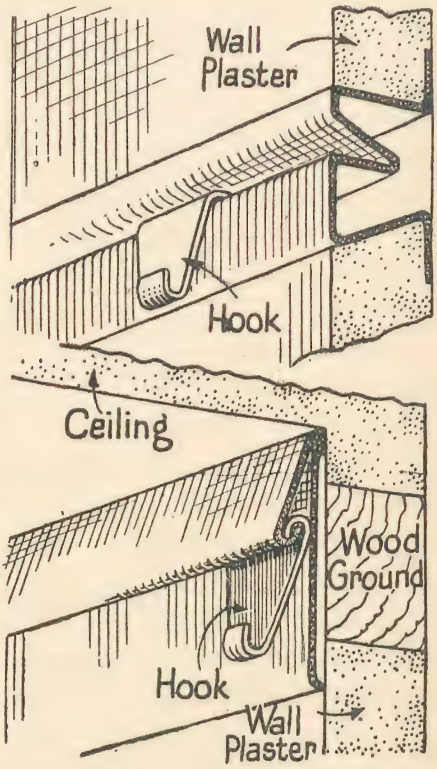


FIG. 13. PRESSED STEEL PICTURE RAILS

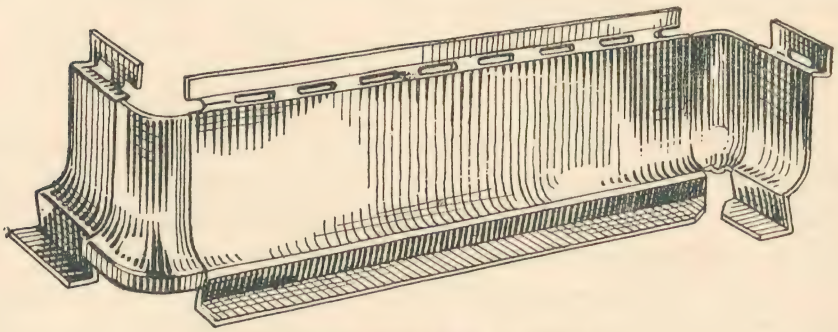


FIG. 14. PRESSED STEEL SKIRTING
The lower flange is concealed under flooring and the upper is built into wall plaster

burnt. If the rot is a slight brown or yellow discoloration it is due to damp only and may be arrested by treating with an odourless preservative—on the back and lower edge.

Metal trim

All the items of interior joinery just described are also made in pressed steel. They are supplied with a priming coat of paint, and in some cases rustproofed. Some typical patterns are illustrated in Figs. 12, 13 and 14.

Metal trim is fixed by nailing, but in addition the edges have a marging or selvidge which is built-in when the plastering is done. There are exceptions. Door linings, for example, have projecting lugs which are built into the wall.

Skirtings and picture rails cannot be fixed to walls after the plastering is completed unless the plaster is cut away and made good after fixing.

CHAPTER XV

SUN LOUNGES AND VERANDAHS

Structures which consist chiefly of glazed walls and roofs are built of framing members called glazing bars designed to hold the glass and the panes or sheets of glass. Usually the glazed walls are built on a low foundation wall which may be a solid wall of brickwork, stone or concrete, or of wood framing covered with boarding or asbestos-cement sheets.

Sun lounges

Sun lounges and conservatories are rooms attached to the house. They may open out of a lounge or a verandah. Plants are grown in a conservatory, and for this purpose some form of cheaply run heating is desirable for use in the winter.

The aspect of these rooms should be southerly, remembering that maximum sunlight is obtained with a direct south aspect for the principal glazed wall, while if most of the glass faces east most of the sunlight will be obtained in the morning, and if it faces west in the evening.

These rooms should have plenty of ventilation. Without this they become too hot in the summer. It is advisable to have about half the wall area to open. Sliding casements are best for this purpose, and by their use a complete wall may be made to open. But sliding casements are costly, and in most cases glazed casement windows or doors in pairs will have to be used. Some top hung transom lights are useful for ventilation in bad weather.

Floor and foundation

Although the walls and roofs of glazed structures are of light weight they need a secure foundation on firm subsoil. The best foundation is a concrete one at least 6 in. thick and 2 ft. wide at a minimum depth of 2 ft. below the ground surface. On this a 9-in. brick, stone or concrete wall should be built and brought up to from 6 to 12 in. above the intended floor level.

The floor should be 6 in. cement concrete levelled over the ground, after removing the top soil. The flooring may consist of granolithic concrete $1\frac{1}{4}$ in. thick or of quarry tiles. Rubber and linoleum stuck down with a special cement can also be used.

A damp-proof course should be laid in the wall at a level about half-way up the floor concrete. On top of this foundation wall

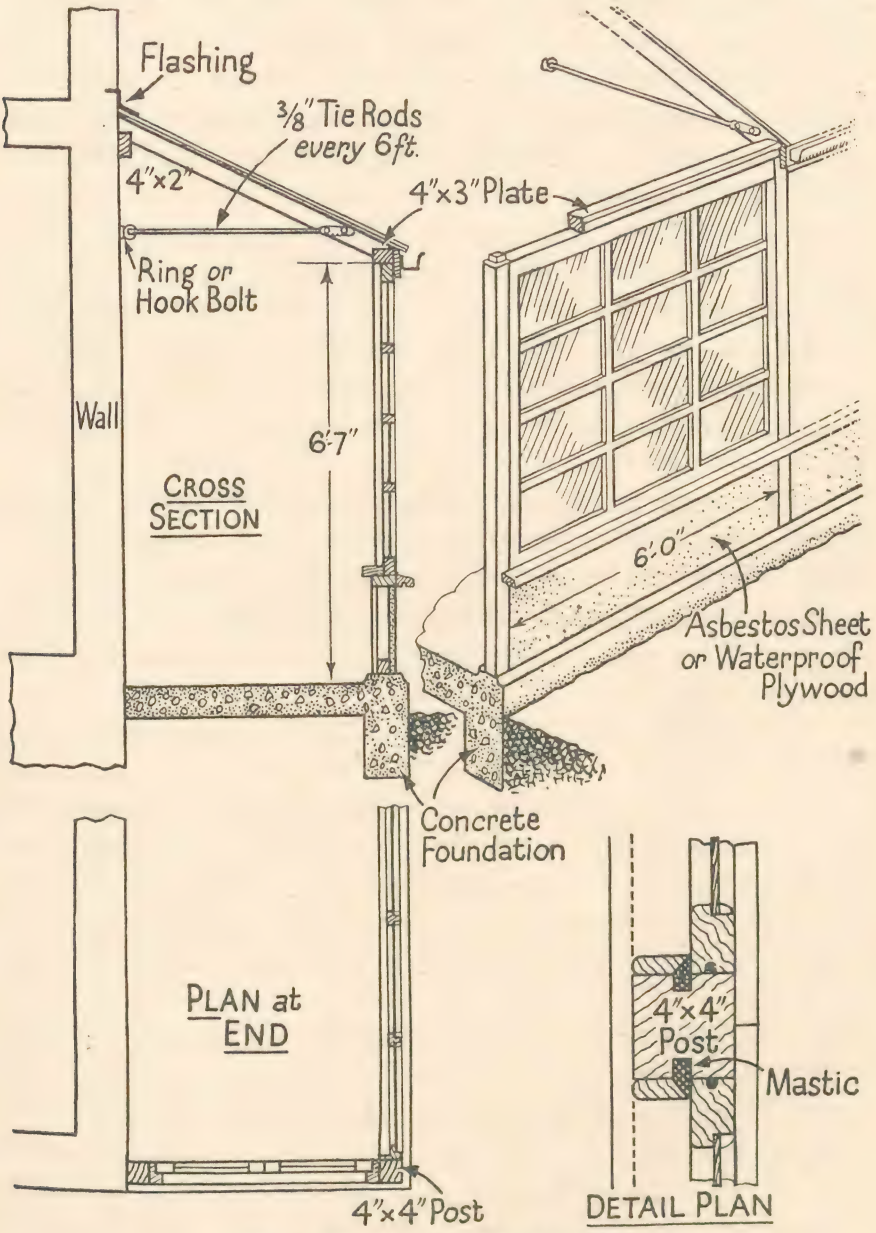


FIG. 1. VERANDAH OR SUN LOUNGE
Window casements can be used for glazing

the wood sill is laid. This sill should project over the outer face about 1½ in. and should have a throating underneath to allow rainwater to drip off. It is advisable to anchor the sill to the brickwork by screwing short lengths of hoop iron to it and then cementing them into the brickwork joints. One in every 3 or 4 ft. is enough.

For all but the smallest structures there should be a system of framing. There should be posts at the corners about 4 in. by 4 in. and intermediate posts at intervals of about 6 ft. The sill should be from 4½ in. by 3 in. to 7 in. by 4 in. according to the size of the structure, and whether the sill is placed at the back or front of the foundation wall.

The head plate should be considered as a beam spanning from post to post. It should be about 6 in. by 3 in. Where there are casement doors there should be the usual door frames at least 4 in. by 3 in. It should be understood that the timber dimensions mentioned here are for a substantial structure. For a lighter structure dimensions can be reduced by an inch each way.

A sun lounge or conservatory is usually built against a house wall and has a lean-to roof. The front where the eaves gutter is fixed should not be too low, and if the lean-to covers a French window opening from the house the eaves should not be below the head of the French window or it will obstruct the view from the room.

Glazing bars

These have already been described and are illustrated in Fig. 10. For light glazed structures built by the handyman the wood bars with putty glazing are generally used, but for the roofs it is just as easy to use the puttyless glazing bars and the wood ones with lead capping cost little more than the ordinary wood bar.

For building glazed walls there are two methods. First, using glazing bars in conjunction with the fixed framework. Second, using casement windows and doors. The first is the cheapest method but is not the easiest for a handyman, as the ends of the bars must be stub-tenoned into the frame members, whereas casement frames can be fixed by screws or nails and no joints have o be cut.

Wood glazing bars for both walls and roofs should be of adequate size. In lengths of about 6 ft. they should be about 4 in. by 3 in. (the finished size will be slightly less). If the pitch of the roof is on the flat side and does not exceed 20 degrees the glazing bars should be at least 5 in. deep for a span of 6 ft. at 2-ft. spacing centres. The same depth of bar may be used for greater spans provided that a purlin or purlins are placed underneath to support the bars. While the dead load of a glazed roof is not much it must be remembered that wind and snow pressure may be considerable. If the roof bars are not stiff enough they will bend and cause the glass to crack.

Wood glazing bars on the roof should be fixed at the feet by cutting a birdsmouth which will allow the bar to "sit" on the plate or beam as shown in Fig. 1. This is secured by skew nailing. With a lean-to roof the heads of bars should be bevelled against a thick board or plate which is secured to the wall by screwing it to fibre plugs. If the roof is of the span type with a central ridge the bars are bevelled against the ridge board. The weight of the roof tends to push the walls outward, though if the length is moderate the sides will be sufficient to prevent this. But if the length is over 10 ft. a tie or collar piece should be fixed to every third bar (or pair of bars, in the case of a span roof). This can be fixed either at eaves level or a little higher.

Glazing and glass have been described (see p. 165). For the roof of a sun lounge or conservatory a puttyless glazing bar is recommended and the glass should be wired. With the house roof tiled or slated galvanized wire guards should be fixed at the eaves immediately above the glass roof so that if a slate or tile falls it will not crash through the glass. These guards will also protect the glass from snow falling from the house roof.

Steel sun lounges

Modern sun lounges are often constructed of steel windows and casement doors with steel glazing bars on the roof. The narrow steel sections do not stop as much light as the wider wood ones, though they are colder and encourage condensation in damp weather.

Standard steel casements, fixed and opening are used, and the structure should be planned with the standard sizes in mind. The separate units are joined by using steel mullion and transom

sections which are supplied by the makers of the steel casements. They are screwed together after packing in mastic. Sliding steel casements are also made which enable the whole of a front or side to be opened at will, but these are more costly.

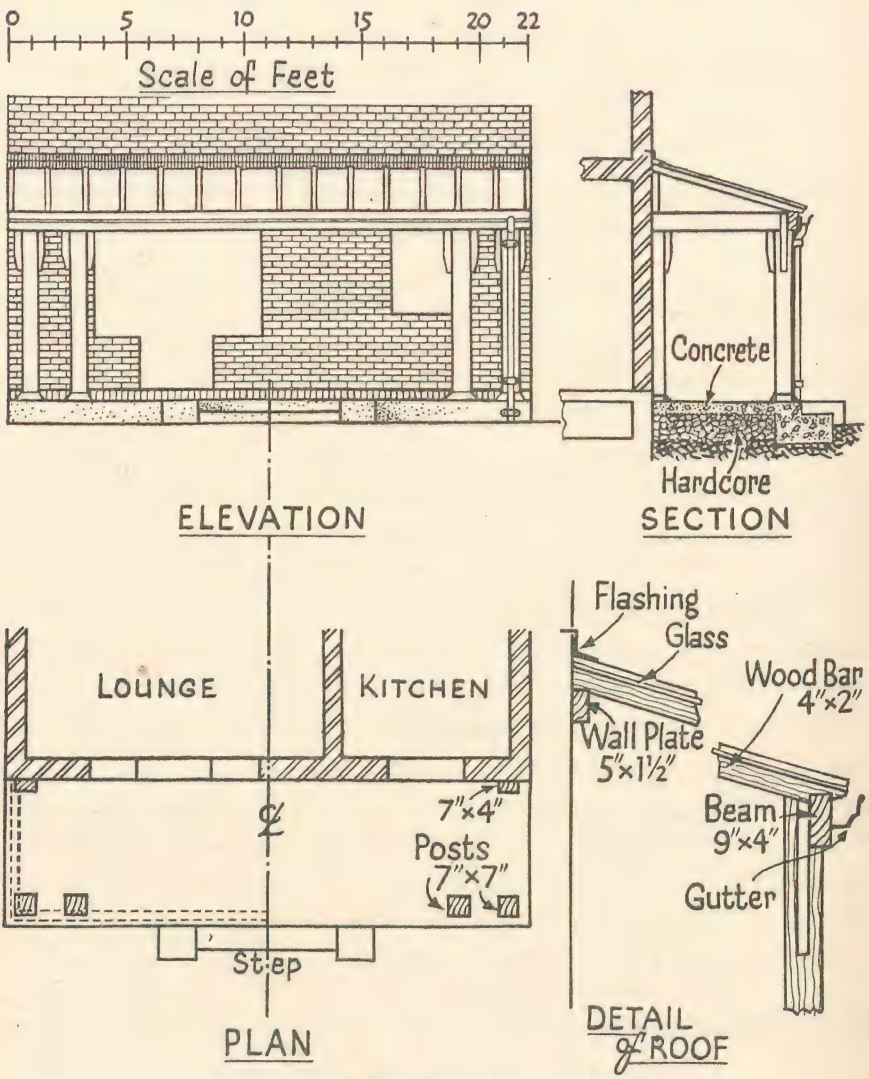


FIG. 2. AN OPEN VERANDAH OR LOGGIA

Verandahs

The principles of construction are the same as for the larger glazed structures, except that the roof bars being of smaller span can be lighter. For a verandah up to 4 ft. span of bar 3 in. by 2 in. bars can be used on the roof.

Verandahs are usually constructed in rather long lengths to

cover the whole front ground floor, or side, of the house. The glazed side should be framed with posts and head beams. The fixed glazing between the posts can be of glazing bars fixed vertically or horizontally, or window casements can be used. Both wood and steel are suitable.

Opening roof lights

The light itself consists of a rectangular frame, and for all but the smallest lights glazing bars are used to give panes of reasonable width—not exceeding 12 in. The fixed glazing bars on the roof are trimmed to form a fixed frame. This is lined with boards about 6 in. deep and the head of the opening light is hinged to the top. A stay is fixed at the bottom to control the opening.

Ready-made opening lights in pressed steel and also in asbestos-cement are made.

Defects in glazed structures

Glazed structures are inevitably subject to considerable condensation inside, but this can be reduced to a minimum by ventilation and heating. But it is no good applying heat without ventilation.

Unless the frames and bars are kept well protected with paint deterioration is rapid. Water entering woodwork joints will set up rot, and if it enters a few cracks in the putty it will gradually lift the putty from the frame. When repainting stop all crevices or gaps in joints with plastic wood or other stopping. If steel windows have not been galvanized or rustproofed any neglect of paintwork will set up corrosion.

As many glazed structures have pitched roofs without cross ties a rather common defect is to have the rafter bars push the sides out slightly. The sides affected should be pushed back to the upright and temporarily strutted, while a few tie boards (or steel rods if preferred) are fixed to prevent the rafter bars spreading.

Sagging roofs is another rather common defect. This is due to the depth of bar being insufficient for the span. A purlin placed under the middle of the span to give intermediate support to the bars will prevent further sagging. It should be a stiff

timber properly supported at the ends. If it is 6 in. by 3 in. for a 10-ft. span it will be stiff enough.

Cracked glass, apart from accidental damage, may be due to movements of the bars. A sagging roof obviously puts a strain on the glass, and if an untied roof pushes the sides out slightly the glazed sides may be distorted and cause the glass to crack. A different cause is having the glass too tight between the rebates. With a tight fit the slightest movement of the bars may cause the glass to crack. And it should be remembered that some movement is inevitable, due to shrinkage, warping and to expansion and contraction with changes of temperature.

Glass slipping down the roof is a rather common trouble where it has not been properly secured in the first place. It is especially common with greenhouse roofs glazed with short lengths of "greenhouse" glass. Each length should be continuous from ridge to eaves and there should be two zinc clips at the eaves, as shown in Fig. 11, to prevent the glass slipping. With patent glazing bars special clips are provided which fit on the bar ends.

Leaks may follow from all the foregoing defects, but faults in flashings and eaves gutters may also lead to leakage. Some handymen try to make the lean-to roof weathertight against the house wall by working a fillet of putty or cement mortar along the head of the glass and glazing bars, but this shrinks and opens a gap. A metal flashing, as illustrated on p. 185, is not very costly and is quite simple to fix.

CHAPTER XVI

OUTBUILDINGS AND SHEDS

Some houses have separate outbuildings containing coal store, w.c., scullery, garage, etc. These are usually of permanent construction. There are also light sheds used for garden tools, play-rooms, summerhouses and garages.

The maintenance of these buildings should not be neglected, especially as they are often exposed to the weather on all sides. Light sheds will rapidly develop defects unless they are periodically painted or treated with preservative and the roofs kept in good condition.

Outbuildings

Outbuildings of permanent construction have brick or stone walls—9 in. thick in brick and about 12 in. in stone. They should have a good foundation with a damp-proof course just below the solid concrete floor. Usually they have span roofs tiled or slated, though the underside may not have a ceiling. It is a simple matter to add a ceiling, using fibreboard nailed to 3- or 4-in. by 2-in. ceiling joists. For maximum headroom these joists can be nailed to the rafters about a third of the way up from the wall plate.

In old houses the floors of outbuildings may consist of brick or stone paving laid on the earth and in poor condition. A new concrete floor with granolithic finish should be provided. If desired the old brick or stone paving can be taken up and broken for use as aggregate for the concrete. But if it is left in position the new concrete need be only 3 or 4 in. thick, as the old paving will provide a firm foundation. The surface should be finished to falls allowing water to run towards the doorway. This makes washing down very easy, especially in garages, sculleries and washhouses.

Although a paving of fine granolithic concrete is best for hard wear a cheaper finish can be provided by bringing the ordinary concrete to a fairly smooth surface and, when it has set, treating

it with silicate of soda, as described on p. 117. This hardens and renders damp-proof the surface, and also prevents dusting up. Old concrete floors can also be treated.

The interior walls are usually whitewashed on the bare brickwork. It is, of course, better to use a washable distemper, and

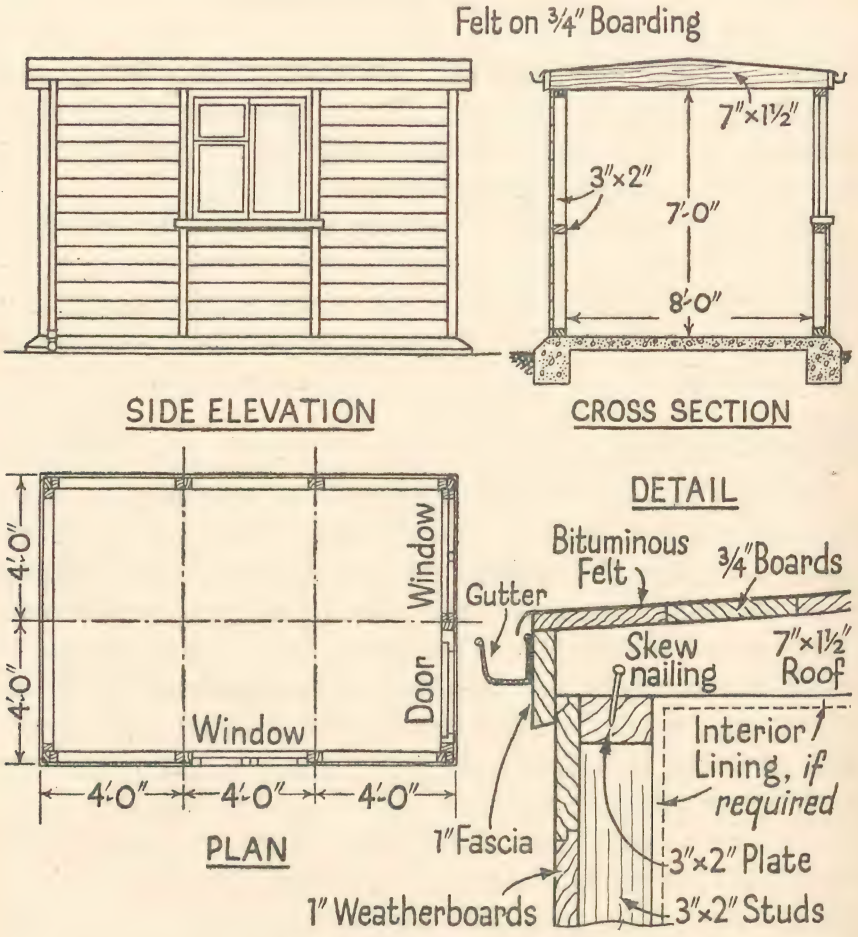


FIG. 1. A SECTIONAL SHED
The same type of construction could be used in building a wood garage

better still an oil paint. But oil paint should be applied on a special priming coat. Otherwise the brickwork will soak up the paint and it will require a lot of work and many coats. New brickwork and concrete are rather difficult to paint successfully, as the free lime, and salts present in the wall, attack the paint. Special primers are sold which give a good chance of success, though it is advisable to wait twelve months to allow the damp and free lime to work out.

Sheds

These are usually timber framed, though steel framing is being increasingly used. The construction should be light but reasonably strong, and it is generally advisable to adopt the

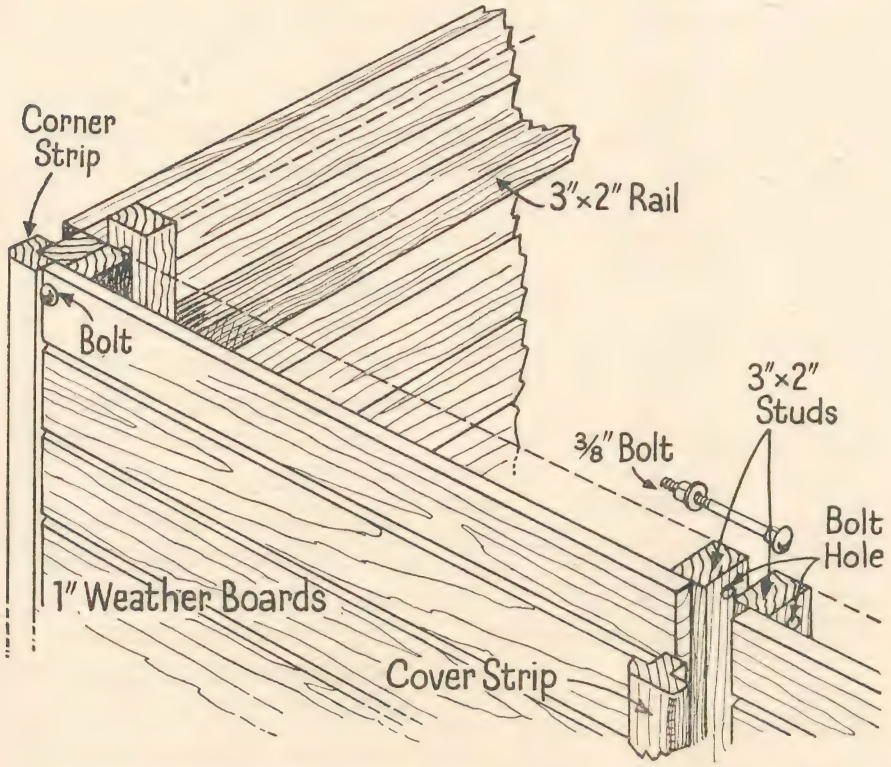


FIG. 2. SECTIONAL CONSTRUCTION FOR WOOD SHEDS AND GARAGES

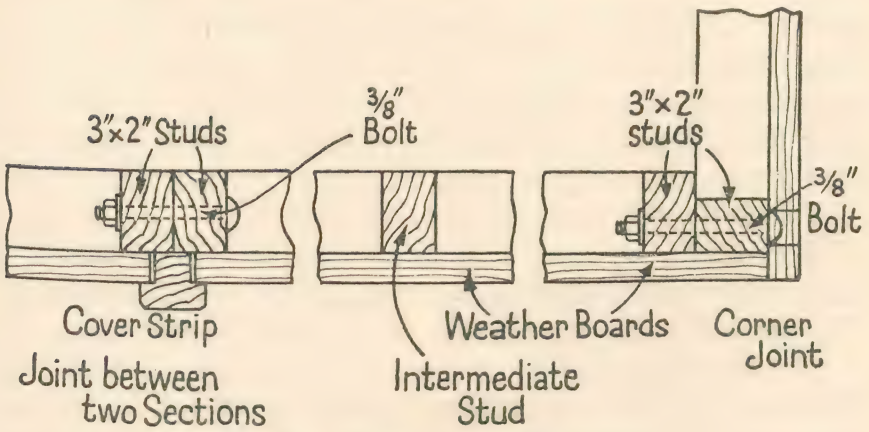


FIG. 3. SECTIONAL HUT CONSTRUCTION
How the sections are bolted together

sectional system so that the structure can be demounted and removed without difficulty.

For all but exceptionally large sheds timber framing using 3-in. by 2-in. material is commonly adopted. The frame consists of bottom and head plates with vertical studs in between. In cheap construction the studs are skew nailed to the plates, but stub-tenoning makes a better job. In the lightest construction the studs are spaced at about 24-in. centres, but 18-in. is better, especially if the interior is lined. Sawn timber is commonly used, but planed timber being more regular in section is easier to fit together, and if the interior is not lined looks better.

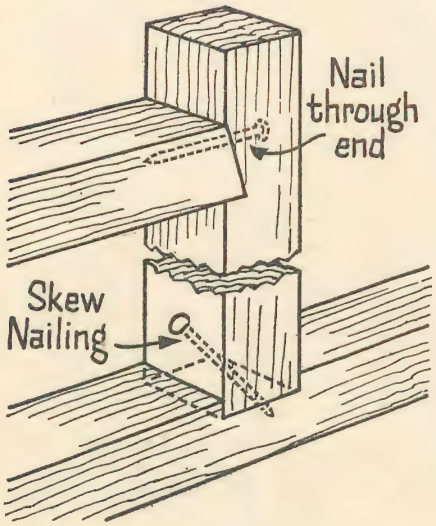


FIG. 4. SIMPLE JOINTS FOR FRAMING SHEDS

The exterior may be clad with weatherboards, asbestos-cement sheeting, either flat or corrugated, or corrugated iron. The roof can be covered with any roofing material. For a cheap roofing of fairly good appearance the flexible "tile" roofings consisting of bituminous felt strips surfaced with crushed slate are recommended. There are several proprietary brands, all quite easy to fix. Cedar shingles look attractive, and these, too, are light and easily fixed. Asbestos-cement slates make a light and durable covering which has the advantage of being fireproof. If natural clay tiles or slates are used the roof and walls must be of stronger construction than usual owing to the heavy weight of these roofings, and the rafters and studs should be spaced at 14-in. centres.

Most sheds are clad with weatherboards. It is better to cover the studs with felting and then nail the weatherboards on. The underfelt will stop draught, dust and rain penetration.

The interior will be much better insulated if it is lined with fibreboard, plywood or asbestos-cement sheets, and, of course, will look better. For garages asbestos-cement or a fire-resisting fibreboard should be used.

Floors may be boarded on joists or be of concrete. Wood floors are warmer and do not encourage condensation. Unfortunately many sheds are built on the ground without proper

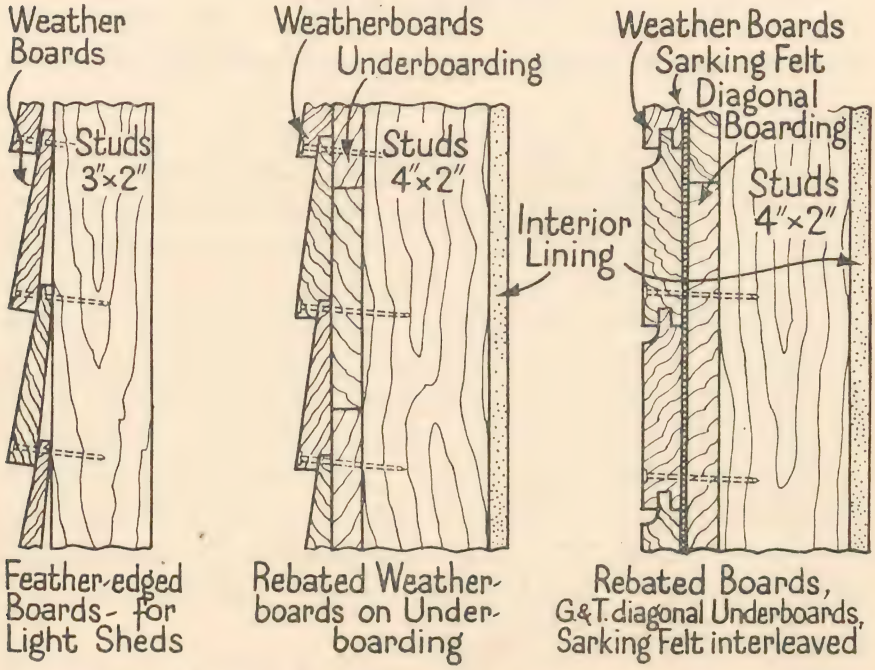


FIG. 72. THREE TYPES OF WALL CLADDING FOR TIMBER CONSTRUCTION

foundation or merely raised on a few bricks. This allows damp to reach the timber and rot follows. A proper foundation with a damp-proof course is necessary, though it may be reduced to 9-in. by 9-in. piers with slates on top to act as a damp-proof course. The tops must be carefully levelled.

gradually washes it out. Nor is it effective for long on the stumps of posts buried in the ground.

Immersion treatment is much more lasting and effective. A large tank is necessary. This is filled with cold creosote, the timber is immersed in it, and then gradually heated to at least 180 F., the temperature being maintained for from one to two hours. The timber should not be removed until the creosote has cooled.

The most effective treatment is by pressure creosoting. This forces the preservative right through the wood, but not many timber merchants have the necessary equipment.

A traditional method of preserving fencing stumps is to char the timber over a fire. This preserves it for several years.

There are proprietary preservatives on the market, some of which are more effective than creosote. One type deposits certain insoluble salts in the pores of the timber. Most of these preservatives are odourless, and some can be painted over.

A chemical preservative which can be cheaply made consists of about 4 oz. of commercial sodium fluoride in crystal form dissolved in 1 gal. of water. Two or three coats of cold solution should be applied with a brush. It is colourless and can be painted over when dry.

Treatment of rot

The decayed and infected timber must be cut out and burnt. Any remaining sound timber should be protected by treating with a preservative.

When timber affected by dry rot has been removed from a floor or other part of a house, the surrounding brickwork and the surface concrete should be sterilized either by brushing an odourless preservative over it or by applying the flame of a blowlamp.

It is useless to treat infected timber with preservative, as the rot will continue through the interior of the wood.

Dry rot often spreads from floors to the backs of skirtings and wall panelling, so this should be removed for inspection and ruthlessly scrapped if the fungus is found. It is most important to burn infected woodwork of all kinds as the spores may be carried from it to other timber.

Insects in timber

Certain beetles thrive in timber. They bore holes through it and in a few years may very seriously reduce its strength. The well-known death watch beetle, which makes a ticking sound, is the beetle which attacks structural timber in buildings. The furniture beetle favours furniture only.

The life cycle of these insects is in four stages. It starts with the egg which is laid in a crack or crevice. From this the larva or grub hatches out. The grub bores through the wood along the direction of the grain, and when it is fully grown it lies up in the end of a boring close to the surface of the wood. Here it changes into a pupa or chrysalis, in which stage it remains stagnant for some time. Within the pupal skin it develops into a beetle. It then emerges, male and female mate, the female lays eggs and the parent beetles then die. To emerge from the end of the boring the adult beetle bites through the remaining wood, so while the interior boring is done by the grub the holes you see on the surface are made by the adult beetle.

A dust called "frass" is produced by the boring, and collects under the timber.

Treatment

Both preventative and curative treatment is by preservatives, already described. Certain proprietary preservatives are better than creosote as they are odourless and also penetrate further into the wood.

Beetles will not attack timber treated with preservative. The effect of preservative on timber already attacked is to kill the beetles and grubs on making contact with them. It is impossible to drive the preservative right through the wood, but repeated applications will cause it to soak in some little distance, and as the larva develops near the surface and the adult beetle must emerge the treatment is eventually effective. But it should be repeated at intervals until infestation has ceased.

If the timber has been seriously weakened by the insect attack it should be taken out and burnt. It may be mentioned that damp and stagnant air have nothing to do with insect attack, so the precautions effective against dry rot are useless against insects.

means of a ball-cock, the working of which will be described later on.

It will be noticed that there is only one pipe leading from the supply pipe on its course through the house. This gives a supply to the cold water tap at the kitchen sink direct from the

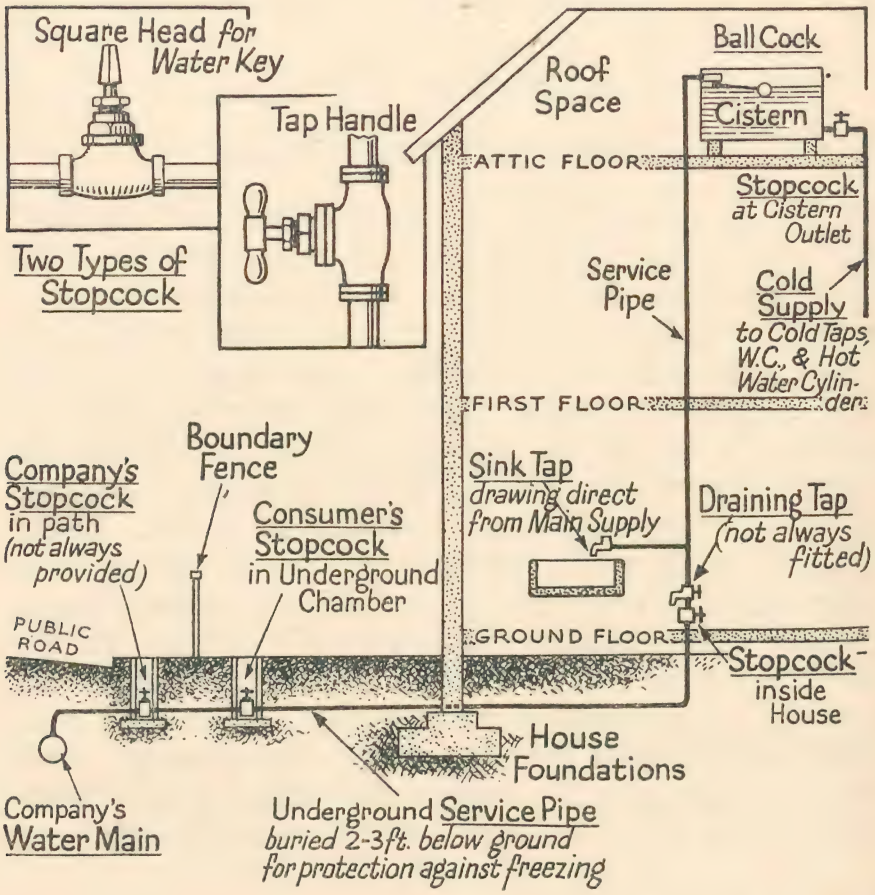


FIG. 1

main, and ensures that the purest possible supply is available at this point for drinking purposes. Contamination of the contents of the storage cistern is always possible, and, if this should happen, water from taps supplied from the cistern would be dangerous to health. For this reason water for drinking and cooking should always be drawn from the kitchen supply, and not from taps in the bathroom or elsewhere. Nor is it wise to use water from hot taps for drinking or cooking.

Stopcocks

In Fig. 1 two stopcocks are shown, one on the underground section of the supply pipe and the other inside the house close to where the supply pipe enters. This is the ideal arrangement, but in many houses one or the other of these stopcocks may be omitted. It is most important to know where these stopcocks are, so that the water can be shut off immediately in an emergency, such as a burst pipe. The underground stopcock may be just inside the boundary fence, in the front garden or in the backyard. It is housed in a small chamber, closed with a small hinged iron cover. This cover should be opened occasionally, the chamber cleaned out, and the hinges oiled; access to the cover should be kept clear, so that the stopcock can be got at quickly at all times. The underground stopcock may be fitted with a handle like an ordinary tap, or it may be fitted with a square head requiring a special water-key for its operation. If the latter, make sure that the key is kept in a known and accessible position, and labelled with its purpose. In either case, of course, the cock is turned *clockwise* to shut off the supply.

The inside stopcock, if there is one, will be found where the service pipe enters the house, usually in the kitchen or scullery. It is usually fitted with a tap head. Make sure that every responsible person in the house knows where it is, and see that it is not obstructed by furniture and the like.

Some water companies insist on a stopcock of their own on the service pipe. This will normally be in the road outside the house, and is not under the householder's control. However, it may be useful to know that it is there.

There should be a third, and most important, stopcock in this part of the cold water system. This should be at the outlet of the storage cistern as shown in Fig. 1. Without this stopcock, shutting off the water outside the house would not prevent the contents of the cistern from emptying themselves through a burst somewhere in the rest of the system. Get to know where this stopcock is also; it may be in the roof-space close to the cistern, but is sometimes placed for convenience below ceiling level in the linen cupboard or bathroom, depending on the plumbing layout of the house.

If it is found that this important stopcock has been omitted

from the system (as it frequently is) steps should be taken to have one fitted. In emergency, the outlet from the tank can be plugged from the inside. If the outlet is in the bottom of the cistern, the end of a broomhandle shaped to fit may be pushed into the hole; if in the side, a large cork cut to fit, or a smaller

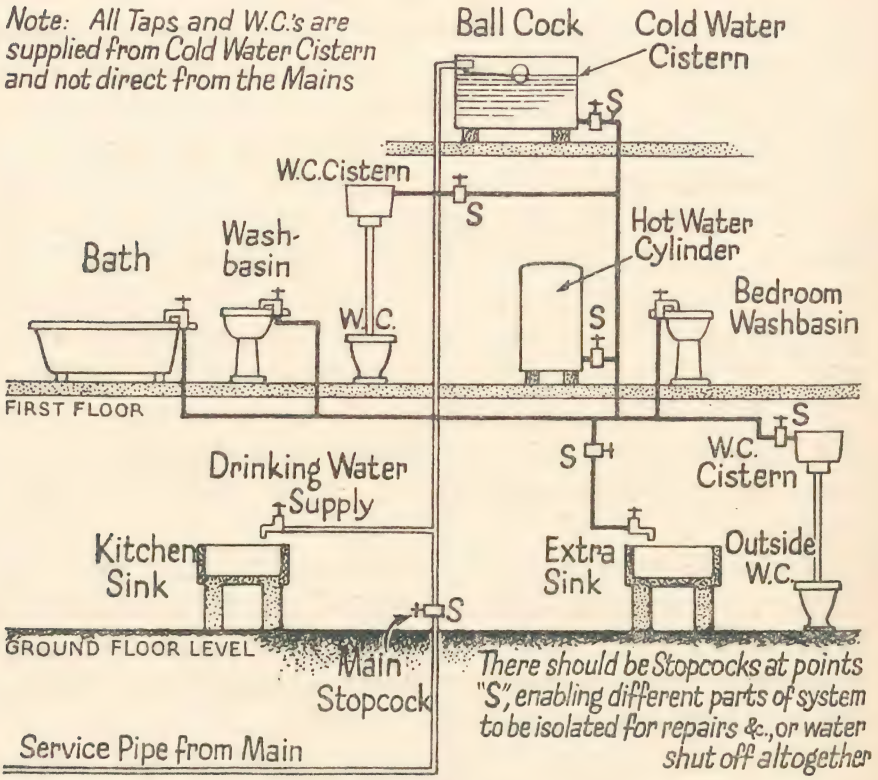


FIG. 2

cork wrapped in a dish-cloth, can be used. This will stop the flow from a burst until repairs can be done.

Cold water supply piping

We now come to consider the supply piping from the storage cistern to various parts of the house. This is illustrated in Fig. 2. In order to make the figure easier to follow, the hot water piping has not been shown in full; details of this will be found in the section on hot water services. With the aid of the figure it should be possible to trace out the course of the various pipes within the house, and it is a wise precaution to do this, and get to know the "run" of the different pipes. The actual layout

will vary according to the plan of the house, but the general principles are the same in nearly all cases. It will be seen, when we come to discuss the prevention of frost bursts, how important the layout of the piping is to proper protection against freezing.

The storage cistern

It might be wondered why all the cold water taps in the house could not be connected directly to the main supply (as is the tap at the kitchen sink) and the additional expense of a separate storage cistern in each house saved. There are two important reasons for the provision of a separate cistern:

(*a*) To ensure a continuous supply in the event of any interruption of the main supply. This is not only a matter of convenience, but is essential for the safety of the hot water boiler. If the supply to this failed, it would quickly become filled with steam and might burst.

(*b*) The water in public mains is usually at a high pressure, which if applied constantly to the domestic plumbing system would cause excessive wear on taps and strain on the piping. Water coming from the storage cistern is at much reduced pressure.

The usual place for the cistern is in the roof space, but in flats and some modern houses it is placed at the top of the linen cupboard, above the hot water cylinder or tank. This latter position has the great advantage that the cistern is protected from freezing. Where the cistern is in the roof it should be fully protected against frost. This is best done by enclosing it completely in a wooden box, leaving a space of about 3 in. all round between the inside of the box and the cistern. This space should be filled with tightly packed sawdust, shredded paper or other good non-conductor of heat. The box should be fitted with a removable lid, which may be covered with sacking as a further protection. Such an arrangement will be found in most well-built houses, but where it is absent, the householder should consider the provision of some form of insulation a worthwhile expenditure. Fig. 3 illustrates a cistern enclosed in an insulating box, together with the arrangement of pipes leading into and out of it.

Failing an insulating box, the cistern should be protected from cold draughts as far as possible by wrapping it in layers

of newspaper or sacking held in place with string. Try to find something which will serve as a cover to the open top, and cover this with sacking, or a piece of old carpet. In very severe weather it is a good plan to leave the trap-door leading to the roof space open, and to keep a lamp or small paraffin stove burning beneath it. This should warm the air in the roof space sufficiently to prevent the cistern and pipes from freezing.

It will be noted that the cistern is fitted with an overflow-pipe, as shown in the Figure. This passes out through the roof and

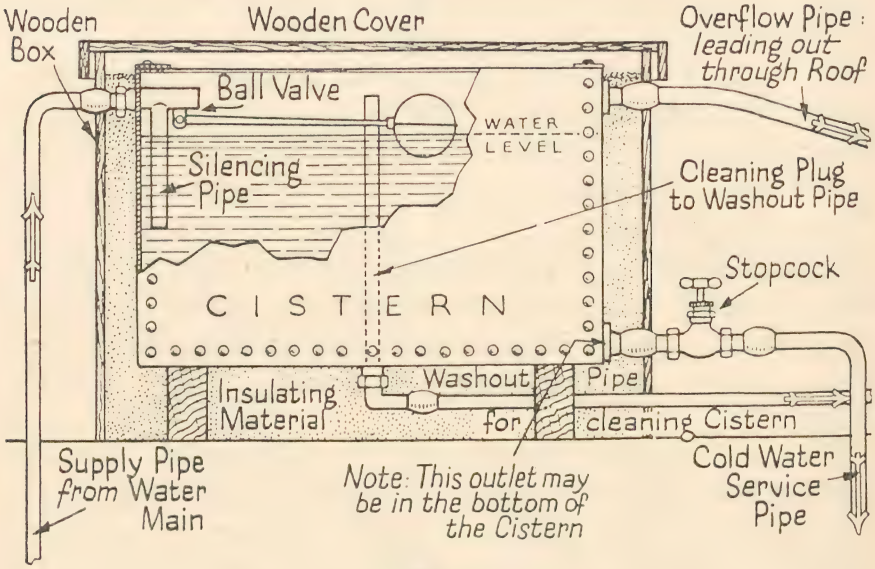

Wooden Box
Wooden Cover
Overflow Pipe leading out through Roof
Ball Valve
WATER LEVEL
Silencing Pipe
Cleaning Plug to Washout Pipe
Stopcock
C I S T E R N
Insulating Material
Washout Pipe for cleaning Cistern
Supply Pipe from Water Main
Note: This outlet may be in the bottom of the Cistern
Cold Water Service Pipe

FIG. 3

acts as a tell-tale should the ball-valve fail and the cistern overflow. Large cisterns are usually fitted with a wash-out pipe as well, so that they can be completely emptied for cleaning. Such a wash-out is shown in the Figure.

Ball valves and taps

Flow of water into the cistern is controlled automatically by means of a device known as a ball valve. This consists of a large hollow copper ball which floats on the surface of the water in the cistern, and works on the end of a long lever (see Fig. 4). This lever operates the control-tap through a crank or fulcrum; when the water is low, and the ball consequently down, the tap is fully open. As the water rises in the cistern the ball rises too, and by means of the lever arrangement gradually shuts off the

water as the full level is approached. When the water level falls, the valve is opened again, and the process repeated. The top water level in the cistern should be about 1 in. below the outlet of the overflow pipe. The level at which the ball valve shuts off the water may be altered by bending the lever carrying the ball float. To raise the level, the arm is bent *slightly* upwards, and to lower it, *slightly* downwards. Great care should be taken not to damage the valve itself when doing this; hold the lever about mid-way with one hand and bend the ball end gently up or down with the other.

Overflowing from the cistern means that the water level is too

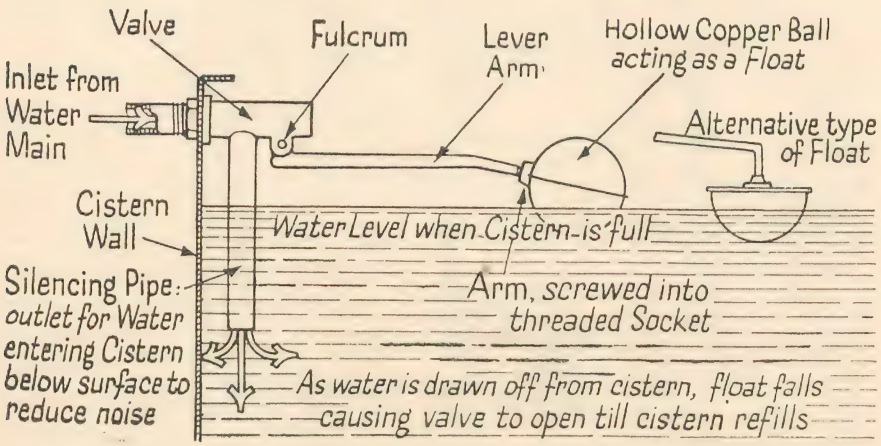

Valve
Fulcrum
Lever Arm
Hollow Copper Ball acting as a Float
Inlet from Water Main
Alternative type of Float
Cistern Wall
Water Level when Cistern is full
Silencing Pipe: outlet for Water entering Cistern below surface to reduce noise
Arm, screwed into threaded Socket
As water is drawn off from cistern, float falls causing valve to open till cistern refills

FIG. 4

high. This may be due to the ball-float being set too high and is easily cured as described above. Other causes may be the float having become punctured, or a fault in the valve itself. Unscrew the ball from the end of the lever and shake it; it should contain no water. If it is punctured, try to locate the hole, and remove the water from inside by shaking. Then clean the metal all round the puncture and repair with a small drop of solder. An old ball may be corroded and leaking in several places. In this case the only remedy is to purchase and fit a new one.

If the valve is apparently at fault, it is easily dismantled. There are several types of valve in use; the two commonest are shown in section in Fig. 5. In both the valve consists of a metal piston, with a seating washer at one end. This is held in

position by means of a screwed cap or plug, usually held by means of a split-pin. First remove the lever arm which carries the ball-float. This works on a fulcrum-pin, and the arm will drop out when this is removed. Then unscrew the cap or plug and take out the valve. Suitable replacement washers can be purchased from an ironmonger. The method of securing the

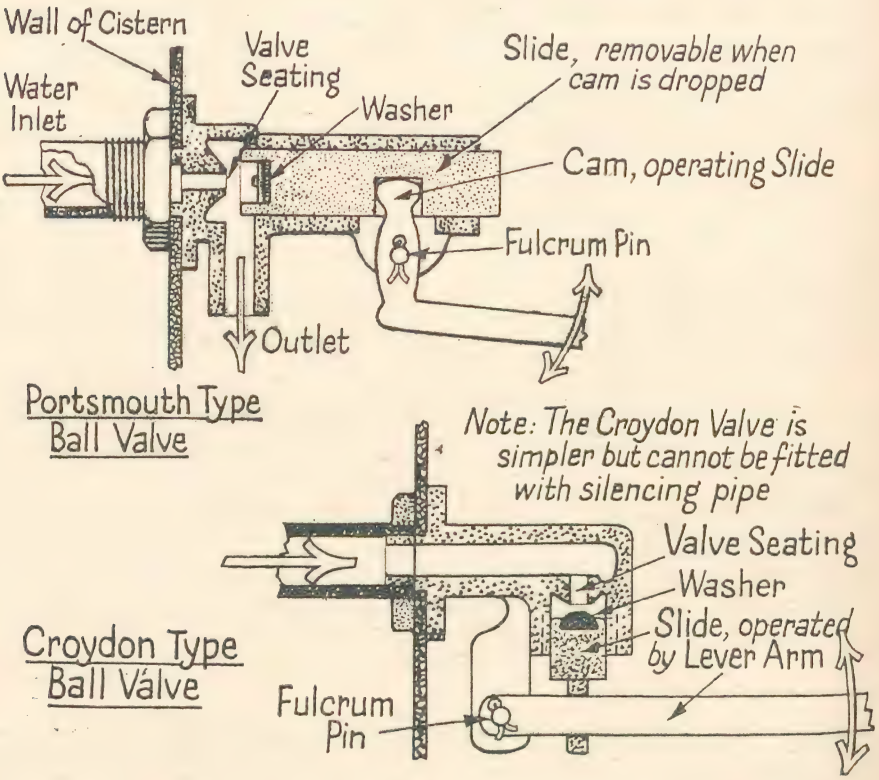


FIG.

washer varies, but will be evident from an examination of the valve. Re-assemble in reverse order, and test.

Many ball-valves are fitted with a silencer-pipe on their outlet, to minimize the hissing noise made by the high-pressure water flowing through the narrow spaces in the valve. The silencer consists of a short length of vertical pipe discharging below water level; there must be a small hole in the pipe near the top to prevent the pipe acting as a siphon. The arrangement is shown in Figs. 3 and 4 and can quite easily be fitted by the householder to a noisy cistern.

W.C. flushing cisterns

The majority of these incorporate a ball-valve working exactly as described above. Adjustments for the correct water level and other repairs are carried out in the same way. The overflow pipe should project through the outside wall of the house so as to act as a tell-tale, and should be large enough to take away the flow from the inlet pipe when flowing at full bore.

The object of the flushing cistern is to discharge a good

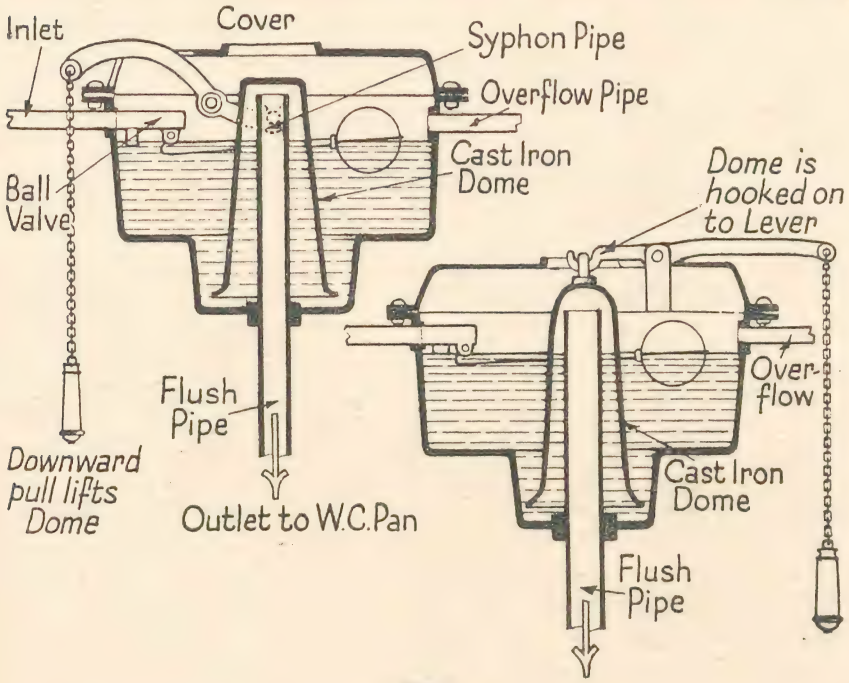


FIG. 6

volume of water rapidly through the flushing rim of the w.c. pan, thus cleansing and scouring it effectively. The cistern usually holds 2 (or sometimes 3) gallons of water, entry of which is controlled by the ball-valve. The whole contents are emptied rapidly down the large flush-pipe to the pan by means of a syphon, operated by pulling the chain. The working of this will be understood on studying Fig. 6. A heavy cast-iron dome, shaped something like a bell, is connected to a lever so that it is lifted by pulling the chain. When the cistern is full the water level inside and outside the dome is the same. The pull of the chain lifts the dome, which falls again rapidly under its own weight. In its fall, it traps the water under it and forces

it up and over the projecting syphon pipe. This sets up a syphonic action which continues until the water level has fallen below the bottom of the dome, admitting air, which breaks the syphon. The flush then ceases and the ball-valve comes into action, refilling the cistern ready for the next flush.

There is little to go wrong with such an arrangement. Complete failure to operate usually means that the lever which lifts the dome has become disconnected from it. Removal of the cistern lid will reveal the seat of this trouble; sometimes the

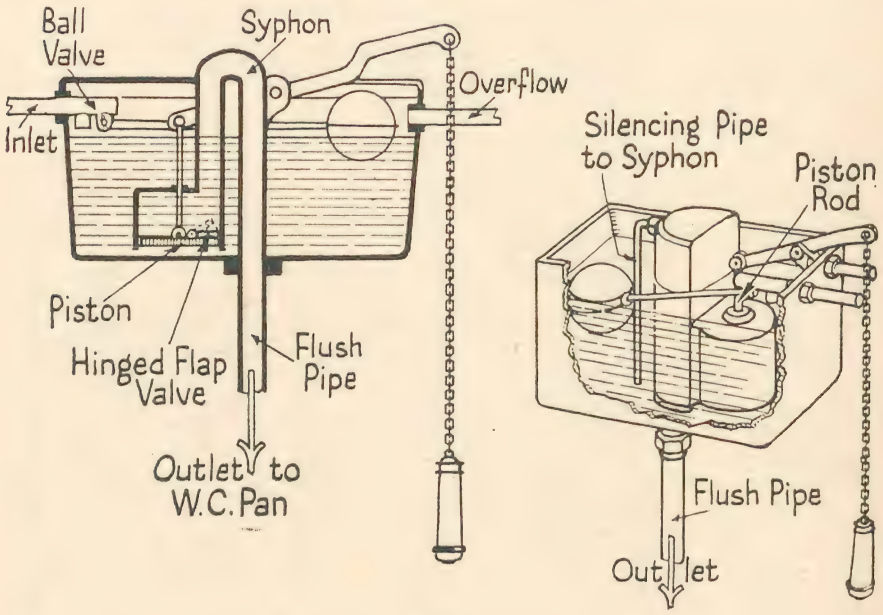


FIG. 7

lever, or the pins upon which it moves, have become rusted through, or the split-pins holding them in position may have fallen out. If it is necessary to pull the chain two or three times before the flush will operate, the trouble is most likely too low a water level. This is easily set right by bending the lever of the ball-float slightly upwards. If the cistern overflows, the ball-valve is at fault and should be examined and repaired as already described.

A more complicated type of cistern, sometimes known as the "Japkap," may still be found, although it is somewhat obsolete today. In this the syphon is set going by means of a piston containing a hinged flap-valve, as shown in Fig. 7. Pulling the chain lifts the piston sharply and sets the syphon going.

As the piston falls again, the hinged flap valve opens, and the cistern is emptied through it by the pull of the syphon. Trouble with this type of cistern is usually due to the flap-valve sticking or to the piston becoming so loose that it cannot force the water over the syphon. In either case renewal of the working parts is the best remedy, and this is best carried out by a plumber.

Repairs to taps

The commonest fault in the domestic plumbing system is the dripping tap, caused by failure to renew worn washers. Few people seem to know that this is a legal offence if it causes water from a public supply to be wasted. The replacement of tap washers is a simple matter, and there is no need to await the services of a plumber to do the job.

Turn off the supply at the nearest stopcock. When the water has stopped running turn the tap to the fully "on" position and remove the handle by taking out the securing screw shown in the section in Fig. 8. Unscrew the easy-clean shield (if one is fitted) and, using a spanner, unscrew the hexagon nut on the body of the tap. Lift out the body of the tap and the spindle, on the bottom of which the washer will be seen. Replace with a new washer and reassemble in reverse order. It is important to obtain a replacement washer of the correct size and to see that it fits snugly on the spindle.

Washers for cold taps are of leather or rubber; cheap composition substitutes are not satisfactory. For hot taps washers are made of special hard rubber, or rubberized fibre, to resist the heat. It is almost useless to fit a cold-tap washer to a hot tap. In hot taps the washer is held in position by means of a small nut and brass washer, while in cold taps the washer is usually merely a tight fit on the spindle. If this nut is difficult to remove hold the spindle in a vice, taking great care not to damage it.

The large ring washer between the body of the tap and the base may be damaged when taking it apart. A new one can be made simply by placing a double thickness of stout brown paper over the opening and tapping all round with the ball of a hammer. This will cut the paper into the required washer shape. Alternatively, the threads may be wrapped round with a few turns of yarn from coarse string which has been unravelled and

greased. The top of the tap must bed down firmly at this point or there will be leakage.

If the tap dribbles at the spindle when the water is turned on the packing in the stuffing-box through which the spindle passes

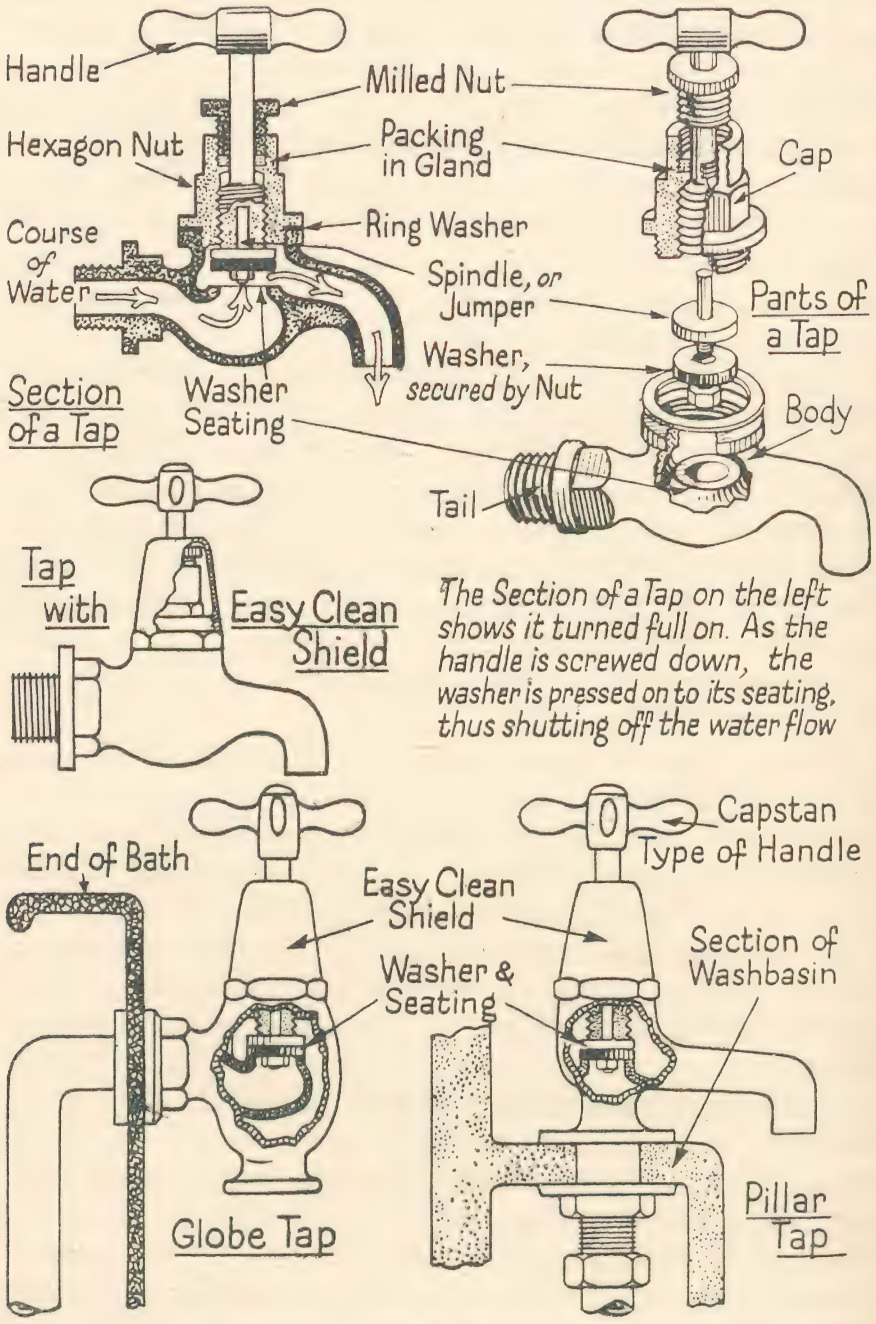

Handle
Hexagon Nut
Course of Water
Milled Nut
Packing in Gland
Ring Washer
Spindle, or Jumper
Washer, secured by Nut
Washer Seating
Section of a Tap
Cap
Parts of a Tap
Body
Tail
The Section of a Tap on the left shows it turned full on. As the handle is screwed down, the washer is pressed on to its seating, thus shutting off the water flow
Tap with Easy Clean Shield
End of Bath
Easy Clean Shield
Washer & Seating
Globe Tap
Capstan Type of Handle
Section of Washbasin
Pillar Tap

FIG. 8

needs renewing. To do this, unscrew the small milled nut at the top of the stuffing-box (see Fig. 8). There is no need to turn off the water when doing this. Remove the nut from the tap spindle and poke out the remains of the old packing. Special string for repacking can be bought, but a new packing is easily made by unravelling some soft string and soaking this in hard grease or tallow. Wind about three turns of the new packing round the spindle and press it down by replacing the milled nut and screwing it down hard. Then remove the nut again and add another few turns of packing. Screw the nut down again hard; there should be enough new packing in the stuffing box for the milled nut to project by several threads when it is fully tightened.

Two types of tap commonly fitted to baths are shown in Fig. 8. These are "globe" and "pillar" taps, the latter being usually fitted on washbasins also. The interior construction is much the same as that of a standard tap, and no difficulty should be experienced in fitting new washers, etc., as described.

Materials for pipework

Cold water plumbing is usually carried out in the familiar lead pipe, with "wiped" joints denoted by a bulge in the pipe. Making these joints and repairing lead pipe is highly skilled work, and not a job for the amateur. Some ways of temporarily repairing lead pipe, pending a permanent job by a plumber, are described below in the section on frost damage.

In modern houses lead pipe has been replaced to some extent by drawn copper pipe with various patent methods of jointing, usually involving a pair of hexagon nuts. These joints will occasionally leak slightly; if this happens tighten the nut or nuts very gently, being careful not to strain the pipe. Where pipework is exposed to view copper pipe is much to be preferred on grounds of appearance.

In certain districts neither lead nor copper can be used for water pipes owing to special chemical properties of the water. Where this is the case, and sometimes elsewhere, galvanized steel tubing with screwed joints is used. Repairs to this are also a skilled matter.

After long usage water pipes may become "furred" inside with a hard deposit which reduces the internal bore. The

common sympton of this is inadequate flow from some or all of the taps. Old galvanized pipework may discharge rusty-coloured water at times; this is unpleasant but is not generally harmful to health. There is no certain cure for these troubles other than renewal of the pipework, which is an expensive matter. However, there are certain compounds on the market which are claimed to remove deposit from pipes. Their use is a skilled matter and should not be attempted by the householder, whatever the claims made by the makers.

Frost damage and protection against frost

It is a curious fact that in a country like ours, where severe frosts are frequent, so little attention has ever been paid by plumbers, architects and builders to protecting the household plumbing system against frost. Most frost damage occurs through inherent defects in, and bad design of, the actual pipework in the house, and there is unfortunately little the householder can do to mitigate such defects, as for example where pipes are run close to the open eaves of an unlined roof space. However, there are certain simple and inexpensive precautions which can be taken by everyone, and which, if thoroughly carried out, will do much to prevent frost bursts.

Storage cistern. This should be thoroughly protected from the cold draughts always present in the roof-space. Methods of doing this have already been described (see pp. 16 and 205). It will be realized that the pipes leading to and from the cistern are equally vulnerable, and these should be very thoroughly lagged as described below. If there are evident points of entry for cold draughts in the roof itself, these should be blocked up as far as possible.

Exposed pipes. All exposed pipes should be lagged, especially cold water pipes. Lagging consists in wrapping the pipe in sacking, felt or similar material. Specially made lagging material can be purchased in rolls, designed for wrapping spirally round the pipe, and if this is carefully applied it makes a very neat job. Copper wire should be used to bind the lagging in position. Blocks of half-pipe shape can also be bought, but the fixing of these is really a matter for skilled hands and should be done by a plumber. Alternatively, sacking or hessian may be cut into suitable strips and wrapped round the pipes over

several layers of newspaper applied first, the whole being tied with string. This will not look so neat but is quite effective. Whatever is done, it is most important that *no part of the pipe be left exposed*. This applies especially to joints and bends, which are not so easy to wrap, and may therefore be left. In very exposed positions, such as an outside tap, the best protection is a wooden box round the pipe stuffed tightly with straw. Remember, in doing this, to carry the protection down well below ground level, for the frost can penetrate the ground at least a foot.

W.C. flushing cisterns. These often freeze up from a cold draught entering the w.c. through the ventilator in the outside wall. For some reason builders seem usually to place this ventilator just where it is most likely to cause the cistern or its feed pipe to freeze. Close the ventilator, or stuff it up in severe weather, remembering to open it again when the frost is past. Leave the door of the w.c. open at night to get warm air from the rest of the house.

Dripping taps. These will cause a sink waste or bath outlet to freeze up in no time. See that all taps are in good repair before winter.

General precautions. Keep curtains drawn in the kitchen and bathroom at night and the windows closed. If the weather is very severe it may be a good idea to leave a small lamp or oil stove burning all night in the bathroom, kitchen or outside lavatory. If you have a continuous-burning stove, leave the kitchen door open at night so that warm air can circulate through the house. There is no need to keep the pipes *warm*; all that is required is to see that the temperature of the air near them remains above freezing-point.

Draining the system. Whenever the house is to be left unoccupied, even for a short period, during the winter months, the water system should be drained. To do this, turn off the water at the stopcock on the service pipe and open all taps in the house. This should ensure that all the various pipe runs are emptied, and is necessary because water left in any pipe might freeze and cause just as much trouble as if no precautions had been taken. Empty w.c. cisterns by flushing after the system has been drained. Insert the drain-plugs into sink, bath and wash-basins; this will prevent remaining drips of water from freezing in the waste pipes.

There is sometimes an additional drain-cock on the service pipe where it enters the house; the purpose of this is to empty the length of pipe below the level of the lowest tap (see Fig. 1). Make sure that this is opened. Finally, after the boiler fire is out and cold drain the hot-water boiler by means of the drain-cock provided on it.

Emergency repairs to burst pipes

Contrary to the popular idea, it is the freezing of the water in a pipe which causes it to burst; the unpleasant results of the burst pipe are not experienced until the thaw comes. Water has the property of expanding when it is turned into ice, so that eleven volumes of water become twelve volumes of ice. This expansion sets up an enormous pressure inside the pipe and causes it to burst.

The first thing to do if a burst occurs is to turn on all taps below the burst and thus reduce the pressure. Turn off the main supply at the stopcock and the cock at the outlet to the storage cistern (see Fig. 1).

If the burst pipe is of lead, and the leak is small, it is often possible to close the hole by gently tapping round it with a small hammer. Then thoroughly dry the pipe and wrap round with two or three layers of insulating tape. Turn the water on and observe the result; the repair may be good enough for the system to be used pending the arrival of a plumber.

For a large burst in a lead pipe, the best thing to do is to flatten the pipe on either side of the burst. Do this by placing a block of wood behind the pipe, and using a fairly heavy hammer. Depending on the position of the burst, it may be possible to turn on the water and use the remainder of the system until repairs can be made.

Copper and galvanized iron pipes usually split along the length as a result of a frost burst. There is nothing the householder can do about this, except to turn off the water and wait for a plumber. Sometimes the pressure will open the patent joints in a copper pipe line instead of bursting the pipe. Depending on the type of joint, it may be possible to reconnect the joint temporarily by taking the joint apart and retightening the hexagon nuts.

Cleaning out the system

Whether the house is left or not, it is a good plan to drain down the whole system once a year and clean out the storage cistern. The interior of this should be perfectly clean, and any sludge or deposit which may have accumulated in the bottom must be removed. After cleaning, the inside of the cistern may be lime-washed. This helps to prevent corrosion and enables any dirt in the cistern to be seen at once. When the system is drained examine ball-cocks and flushing cisterns and make sure that all is in order.

Hardness of water

In many districts, especially those which draw their water supply from chalk deposits, the water may be "hard," due to certain chemicals dissolved therein and derived from the underground sources. The most serious effect of hardness is the incrustation of the interior of pipes, and of boilers and cylinders in hot-water systems. The deposit is the same as the "furring" which occurs inside a kettle, decreases the flow in pipes and causes boilers to become less efficient. Hardness of water also reduces the value of soap, so that more of it has to be used to obtain the same result.

Where local water is very hard it is the usual practice to collect rainwater, which is "soft" because it contains no dissolved chemicals, for clothes-washing and similar purposes. An underground tank fitted with a hand-pump is often used. Owing to the dangers of pollution such water should *never* be used for drinking or cooking.

Water-softeners

A water-softener is a device for removing the dissolved hardness from water by chemical means. The usual domestic type employs what is known as the "base-exchange" system, in which the water to be softened is passed through a bed of a special chemical, which has the property of absorbing the hardness. After a certain quantity of water has passed through the bed it becomes exhausted and has to be revived by the application of a solution of common salt, which passes to the drains; after this process the bed is ready for a further cycle.

There are many different types of softener on the market,

most of them expensive to purchase. It is important to instal a softener large enough to deal with the amount of water used. Expert opinion should be sought before installing water-softening apparatus; it is not always wise to accept the claims of the makers of these machines as fully justified.

Water supply from wells

To those in country districts, and still dependent on well-water, a few words of caution may not be out of place. It is often claimed that the water from a certain well or spring has been "tested" and found fit for drinking. It is important to remember that pollution may have occurred *after* the test was made; such sources are *always* liable to accidental pollution (except for deep wells and boreholes), and a satisfactory test must not be taken as a certificate of safety for the particular source for ever afterwards. Water from shallow wells (all wells with an open top are classifiable as shallow, whatever their depth) and springs should *always* be boiled before use for drinking or cooking. The same applies to the piped supplies in many villages, which are often grossly polluted.

Unfortunately, appearance and taste are no guide to the purity of a water supply. The clearest and most sparkling water from a spring may contain millions of deadly bacteria, if, as is so often the case, a cess-pool or farmyard is close at hand.

CHAPTER XIX

HOT WATER SERVICES

The usual practice in this country is to provide each house or flat with its own separate means of heating water. What is termed "district heating," in which hot water from a central boiler-house is supplied to a large number of houses as a public or landlord service, would be more economical and convenient and is likely to become general in the future. Meanwhile the householder must rely on his own boiler and supply of fuel, which may be coal, coke, electricity or gas, for water heating.

Layout of system

In the majority of houses the kitchen fire (or sometimes that in the living-room where cooking is by gas or electricity) is also used to heat water, by means of an incorporated boiler. Water is supplied to the system from the cold-water storage cistern, and when heated is stored for use in a hot-water *cylinder* or tank. The arrangement of the pipes is shown diagrammatically in Fig. 1. As will be seen later, the layout of the pipework is important, for the system will not work efficiently unless this is properly designed. Many householders who rightly complain that they "cannot get hot water" are suffering from the faults of design and construction which are still all too common. In the description which follows some methods of improving inefficient systems will be suggested.

The boiler and cylinder are connected by two pipes, the "flow" and "return" pipes. It is essential that these pipes be as short as possible, and that long horizontal runs be avoided; otherwise there will be great loss of heat. Both pipes should preferably be well lagged with proper insulating material—work which can best be done by a plumber or builder. The cylinder is usually fixed on the first floor, as nearly over the boiler position as possible, and serves also to warm a linen cupboard. A cold-water *feed-pipe* leads into the bottom of the cylinder from the cistern above. From the top of the cylinder runs a vertical pipe,

called the *expansion pipe*, which leads up to the cistern and is bent over so as to discharge into it, as shown. The *secondary flow* leads from a tee-connection at the bottom of the expansion pipe and takes hot water to the various taps. This is the simplest form of system; there are certain elaborations often fitted to

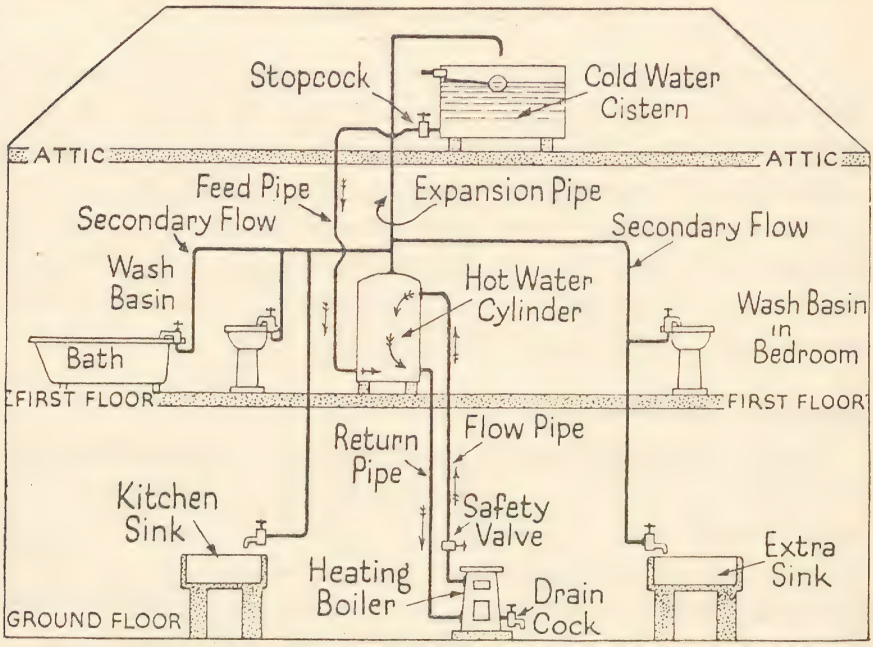


FIG. 1

obtain greater efficiency. These are best described when the working of the system is understood.

How the hot-water system operates

Pressure from the cold-water cistern keeps the whole system full of water, the level in the expansion pipe normally being the same as that in the cistern. As water is heated it becomes lighter in density, and, weighing less than the equivalent volume of cold water, it tends to rise. Thus, as the fire heats the water in the boiler, the warm water rises up the flow-pipe and is replaced by cold water coming down the return pipe from the cylinder. Circulation is set up, the heated water collects towards the top of the cylinder, and this gradually becomes full of hot water. If no hot water is drawn off through the taps, and the fire is kept burning brightly, the water in the cylinder becomes hotter and hotter and will finally boil. (Of course,

this should not be allowed to happen. Not only is fuel being wasted, but steam may collect somewhere in the system and may do serious damage. If the water in the system does boil, damp down the fire at once, and draw off some of the hot water.)

The purpose of the expansion pipe will now be clear. It is to allow for the increased volume of the water in the system as it heats up, and also to carry off any steam which might be formed by boiling. However, it is possible for it to become blocked or frozen, so it is not a 100 per cent. safeguard against the effects of boiling.

When hot water is drawn off from a tap it is replaced by more cold from the cistern through the feed-pipe, and so into the bottom of the cylinder. Thus the capacity of the system is limited by the size of the cylinder; if this is too small for the usual requirements of the house the hot water will quickly run cold, and no amount of "stoking up" will ensure an adequate supply. For a normal four-bedroom house a 20-gallon cylinder is usually fitted. This is adequate, but a 30-gallon size is better.

The hot-water cylinder

A normal type of cylinder, and its connections, is shown in Fig. 2. It is a cylinder-shaped tank with a slightly domed top, and a dished bottom, to give added strength. It is made either of galvanized steel or of copper. The latter material is probably the better for the purpose and is preferred in modern building; but with a copper cylinder it is very important that there should be no galvanized piping in the system. If there is, a chemical action may be set up which will destroy the cylinder quite rapidly.

The cylinder provides far more heat than is required to

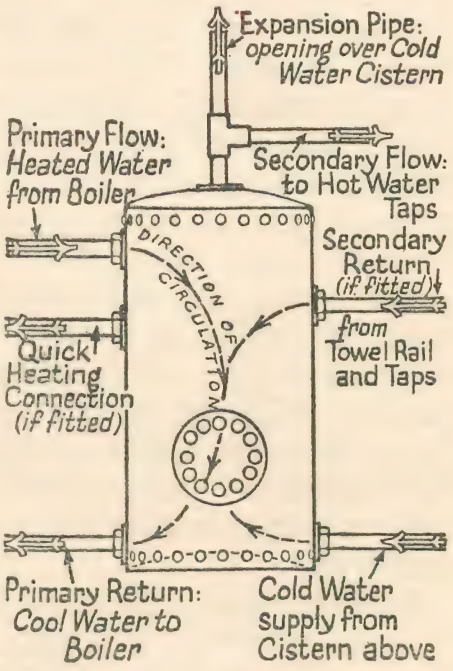

Expansion Pipe: opening over Cold Water Cistern
Primary Flow: Heated Water from Boiler
Secondary Flow: to Hot Water Taps
Secondary Return (if fitted)
from Towel Rail and Taps
DIRECTION OF CIRCULATION
Quick Heating Connection (if fitted)
Primary Return: Cool Water to Boiler
Cold Water supply from Cistern above

FIG. 2

warm a linen cupboard, and it is essential that it should be lagged the interests of fuel economy. Special asbestos or insulating in quilt jackets can be obtained for this purpose, designed to fit the standard type of cylinder snugly. Failing this, wrap the cylinder in several layers of newspaper or corrugated cardboard, tied with string. Cover this with hessian or sacking. A very considerable saving of fuel will result, besides a better supply of hot water.

As will be seen from the Figure, the cylinder is provided with a "mud-hole" for cleaning purposes, held in place by a number of hexagon set-screws. In districts where the water is "hard" (see p. 217) scale collects on the inside of cylinders and should be removed from time to time. This is best done by a plumber, and should not be necessary more than about once every three years.

Sometimes the cylinder is replaced in the system by a rectangular galvanized tank, but the functioning is exactly the same. It is important that either tank or cylinder should be raised slightly above floor level so as to allow free circulation of air beneath.

Boilers

There are two main types of domestic boiler: the "back boiler," incorporated in a kitchen range or living-room fire, and the independent boiler, in which the fire is used for water heating only. The former type can be very satisfactory if properly designed and set, but in general the independent boiler is much to be preferred. It too often happens that the size, and position in relation to the fire, of back boilers is governed by the space available rather than the amount of hot water required. As gas and electric cookers have cut out the use of the kitchen fire for this purpose, independent boilers have become more and more popular. Most types of grate incorporating a back boiler should be regarded with suspicion. There is no doubt that they *can* work satisfactorily under ideal conditions, but the fact is that they generally do not, and are a source of much trouble to the householder.

With any type of back boiler it is most essential to keep the flues perfectly clean. Openings in the grate are provided for this purpose, and the flues should be raked or swept at least once

a week. Control dampers should work freely and be replaced if corroded or broken. Keep a clean, bright fire, and see that the fire does not get clogged with clinkers or ashes, which prevent the heat from reaching the boiler.

All boilers are liable to become scaled inside, and the harder the water supply the more quickly this will happen. Most types incorporate a mud-hole for the removal of scale, and this is a job which should be done regularly by a plumber. Scale inside the boiler not only acts as an insulator against heat from the fire but reduces the size of the waterways. If the hot-water supply in the house is not satisfactory the first cause to suspect is that the boiler needs de-scaling, especially if this has not been done for some time. In hard-water districts once a year is not too often to have the boiler de-scaled; the small cost will be repaid in subsequent saving in fuel.

There are many types of independent boiler on the market, and any well-known make should give satisfaction. If the boiler is installed in the kitchen the top can be used as a hot-plate, and the fire warms the room in winter. The disadvantage is that the kitchen may become uncomfortably warm in summer. One way of overcoming this is to have a supplementary gas or electric water heater incorporated in the system so that the fire is not used in hot weather. De-scaling is equally important with any type of independent boiler and must be attended to regularly. The flue pipe leading into the main chimney must also be kept clear; a soot door for this purpose will usually be found on the elbow where the flue-pipe enters the boiler.

Safety valves and boiler explosions

If the system has been properly looked after the dangers of explosion in a domestic boiler should be quite negligible. However, all such boilers should be fitted with a safety valve as an added safeguard. This is a device arranged to "blow off" and release excess pressure due to the formation of steam inside the system before the pressure reaches a dangerous level. The safety valve should be tested by a plumber at regular intervals, say each time the boiler is de-scaled.

An explosion of the boiler can only occur when either the flow or the return pipe, or both, are blocked by ice or "furring" due to hard-water deposit. Inefficient working of the system,

with "bubbling" or "knocking" noises in the boiler, should give adequate warning of the latter state of affairs. In the case of back boilers fitted into a fireplace on an outside wall there is a danger of the flow or return pipes freezing, as these are usually led up inside the wall, where they are especially exposed to frost.

Quick-heating connections

The hot-water cylinder is large enough to provide all the hot water needed at times of peak demand, when baths are being taken. At other times much smaller quantities of hot water are used, and fuel may be wasted in keeping the whole contents of the cylinder hot enough for use at the sink. To overcome this difficulty a quick-heating connection may be fitted to the cylinder.

It has already been explained how the water heated in the boiler collects at the top of the cylinder, while cooler, or cold, water passes from the bottom of the cylinder to the boiler through the return pipe. Thus the boiler fire is heating the whole contents of the cylinder. If a branch from the return pipe is taken into the cylinder higher up, and circulation to the bottom shut off by means of a valve, only the contents of the top quarter of the cylinder will circulate through the boiler. A much smaller fire can be used then to supply enough hot water for non-peak needs. The arrangement is shown diagrammatically in Fig. 3. To change over from "quick-heating" to normal heating, and vice versa, it is only necessary to open or close the quick-heating valve shown.

The fitting of such a connection to a normal hot-water system need not be an expensive matter and is generally well worth while. The important point to note, if such a connection is fitted, is that every responsible member of the household should understand what the valve is for and how to operate it.

Secondary circulation pipes

In the layout shown in Fig. 1 it will be seen that the hot-water taps are on a "dead end" of pipe. The result of this is that if a tap has not been run for some time the whole contents of the pipe connecting it to the cylinder must be run off before hot water is delivered. This is very wasteful both of water and

of fuel, the latter because, after the tap has been run, the pipe is left full of hot water drawn from the cylinder and this remains in it to become cold.

If the taps are placed on a continuous loop of pipe connected back to the cylinder, as shown in Fig. 3, hot water will circulate round the loop and instant hot water be available at the taps. Such secondary circulation may be carried through a heated towel tail in the bathroom, or even a small radiator for general space heating upstairs. Naturally such a layout is more

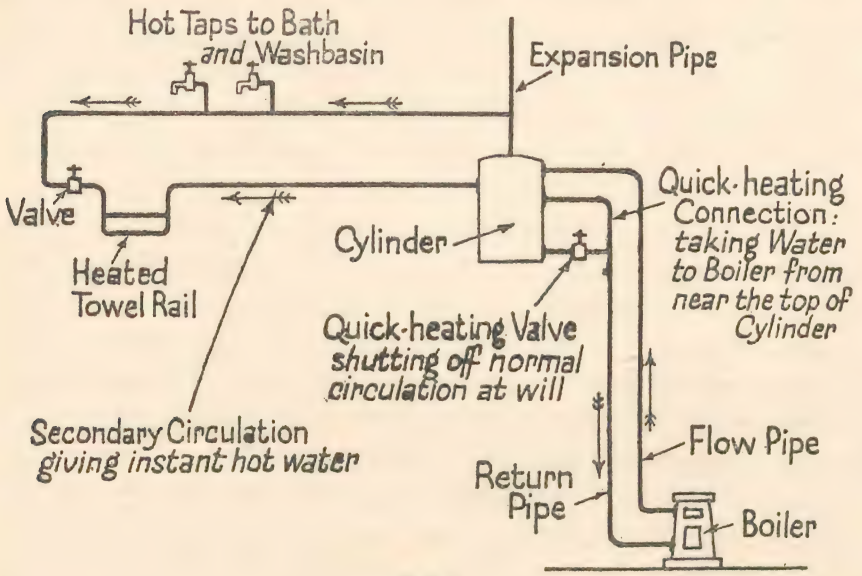


FIG. 3

expensive to install, as it needs more pipework, and it is thus not usually found in houses in which low cost of building has been the first consideration. Whether or not secondary circulation can be added to an existing system without large expense will depend on the layout of the house. In the ordinary type of semi-detached house the work should not be difficult or expensive, if entrusted to an experienced plumber. Note that it is not possible to have a water-heated towel rail without secondary installation.

Gas and electric water heaters

The main appeal of gas or electricity for water heating is to convenience and cleanliness. Both means, properly installed and used, can be highly efficient and economical. However,

like most efficient modern devices, the appliances available are all designed for use in specific circumstances, and the cost of fuel may become prohibitive if they are put to uses for which they were never intended. For example, householders have installed electric immersion heaters intended to act as auxiliaries to a fired boiler and then complained bitterly at the cost of using the immersion heater alone to provide hot water for the house.

The two main types of appliance are *instantaneous* heaters and *thermal storage* heaters. The former almost always uses gas and takes the form of the well-known "Ascot" type or the older gas geyser. (Electric geysers are hardly known in this country, for they take a very large current for a short time—a type of loading least desired by the electricity suppliers.) The thermal storage heater is a complete unit for heating and storing water, and both gas and electric types are widely used.

The instantaneous gas heater is ideal for placing over a sink or isolated wash-basin. It is so arranged that the gas flames are lighted automatically by the act of turning on the water, and turned down again by a device known as a thermostat as soon as the water runs at the desired temperature. The working of these devices is delicate and complicated; adjustment and servicing is a matter for the gas company's fitter.

A development of this type of heater is the "Multipoint" gas heater, supplying water to taps in various parts of the house. Such heaters can be used as the sole means of hot-water supply and also as auxiliaries connected into a normal boiler system.

The principle of the thermal storage heater is the use of a small gas flame, or small electric current, to maintain the contents of a heavily lagged storage tank at a constant temperature, control being entirely automatic by means of a thermostat. Such heaters are made in sizes from 1½ gallons to 12 gallons, and sometimes larger. The important thing to remember is that this type of heater is not designed to provide large quantities of hot water at short notice, but a constant supply of small quantities as needed. Intelligent usage is necessary if the heater is to be efficient and economical. If, for example, the whole contents of a 1½-gallon storage heater over a sink are drawn off at once, not only will nothing but cold be available from the heater for an hour or so, but the current will be on continuously and the running cost correspondingly high. The same applies, of

course, to gas-fired thermal storage heaters. Such appliances should require no attention from the householder, but should be serviced periodically by the electrician or gas-fitter.

Electric immersion heaters are screwed into the hot-water cylinder, and usually thermostat controlled. Their use should be restricted to acting as a "booster" to the main system only. When the boiler is not in use the immersion heater must be switched off or the current consumption will be prohibitive.

Fuels and fuel costs

The use of the correct fuel for the type of boiler installed is very important. Some modern boilers of the independent type are designed to burn anthracite nuts, or small coal of a certain size, and will not operate properly on any other fuel. Most types are designed to burn coke, or coke and coal mixed, and these can be banked down at night by mixing a certain amount of household rubbish with the fuel. For some time to come it is probable that the householder will be forced to take whatever fuel the coal merchant can supply, and thus boilers requiring special fuels will be at a disadvantage. In general, small coke is far more efficient in an enclosed fire than coal. The coke may be mixed with coal dust or slack, but the proportion of the latter should not be too high or blocking of the flues may result.

Curing faults

Many possible faults of design or operation have already been dealt with, but there are one or two special ones common enough to warrant special mention.

Drying up of hot water. It sometimes happens that the hot-water taps in a bungalow or flat will give a spurt of hot water and then cease to run. This happens because there is not enough difference in level between the cold-water cistern and the taps. The remedy is to increase the size of the cold-water feed-pipe from the cistern to the hot-water cylinder.

Noises in the boiler or pipes. These are almost always caused by the formation of steam due to overheating. Draw off a quantity of hot water and damp down the boiler fire. If the noises are repeated after a time it means that the boiler badly needs de-scaling or that the flow or return pipes to it are badly "furred." Have these matters attended to at once.

Failure of boiler to heat water. This may be due to the causes stated above, to dripping taps causing loss of hot water, lack of lagging to pipes and cylinder or simply to bad design of the system. If water is heated by a back boiler see to the flues and make sure that they are perfectly clear.

Hot taps run cold at first. Caused by loss of heat from exposed pipework, which should be lagged. Aggravated by lack of secondary circulation (see p. 224).

CHAPTER XX

DRAINAGE

The word "drainage" is often used as meaning only the system of buried pipes which carries away waste liquids from the house, but properly the term also includes the sanitary fittings and the outlet pipes which connect them to the underground part of the system. Here we shall be discussing the sanitary services of the house as a whole, and using the word "drainage" in its wider sense.

It is of the utmost importance to health that the drainage system should be properly designed and constructed, and kept in first-class working order. Bad smells arising from defective drains may not in themselves be a danger to health, but the defects which give rise to them are a constant menace to life itself. It is for this reason that local byelaws controlling drainage matters are strict and very rigidly enforced. Plans of any new drainage system, or of proposed alterations to an old one, must be submitted to the local council offices for approval; after this is obtained the work will be inspected by a sanitary officer employed by the council, and may not be put into use until passed by him.

The legal aspects of local byelaws are dealt with in Section I and need not be further considered here. However, a general tip worth noting is that the householder who is contemplating alterations to a drainage system, or who is dissatisfied with the working of his house drains, should start by getting in touch with the sanitary officers of the local council. Make a friend of the Sanitary Inspector and take his advice as to what should be done. The advice given will be sound and based both on technical knowledge and wide experience. It is a great mistake to imagine, as some people still appear to do, that drainage byelaws are another example of unnecessary restriction upon personal liberty, to be evaded so far as may be possible. They exist for the protection of the public health, and co-operation with those officials whose job it is to see that they are enforced is much the easiest and cheapest way out in the end.

Where the householder is a tenant it is worth remembering that local councils possess ample powers to compel property owners to rectify any insanitary conditions which may exist. If serious defects in the drainage system are suspected, the Sanitary Inspector should be asked to make an inspection. Should the drains prove to be defective, a word from him to the landlord is usually all that is necessary to cause immediate repairs to be carried out.

Principles of a house drainage system

The basic object of any drainage system is to remove from the house, completely and quickly, all waste liquids and convey them to a point of disposal without nuisance or smell. This is achieved by means of a system of watertight piping, mainly laid underground, and provided with means of access for cleaning in the form of manholes or removable access plates on exposed pipes. The whole system is kept isolated from the house by means of water seals incorporated in the pipework, which are called "traps." Thus a bath waste is said to be "trapped" by means of the U-shaped bend just beyond the outlet, which contains a permanent water seal, and thus prevents foul air from the drains coming back up the pipe and entering the house (see Fig. 8, on p. 241). Every sanitary appliance in the house is trapped in this way, and there are additional traps on the underground part of the system as an extra safeguard.

Description of layout

It is the statutory duty of the Local Authority to provide and maintain efficient public sewers throughout its district, and the householder's responsibilities end at the point of connection of the drain from his house to the public sewer. This is usually located in the road opposite the property frontage, but in certain cases may be elsewhere. There are three systems of main sewerage, and the layout of the house drains will depend on which of these systems is in use in the particular locality. The three systems are:

Separate. Here the flow from baths, sinks, w.c.'s and other sanitary appliances is treated as "foul water," and kept strictly separate from the rainwater from roofs and yards, which is called "surface water."

Partially separate. Surface water from the front of the house is connected to the foul-water sewer, along with foul water from the house. Surface water from the back of the house is connected to a separate surface water sewer.

Combined. Here both foul and surface water are connected to the same sewer.

A typical system of house drainage adapted to each of these three systems is illustrated in Fig. 1. It will be seen that the

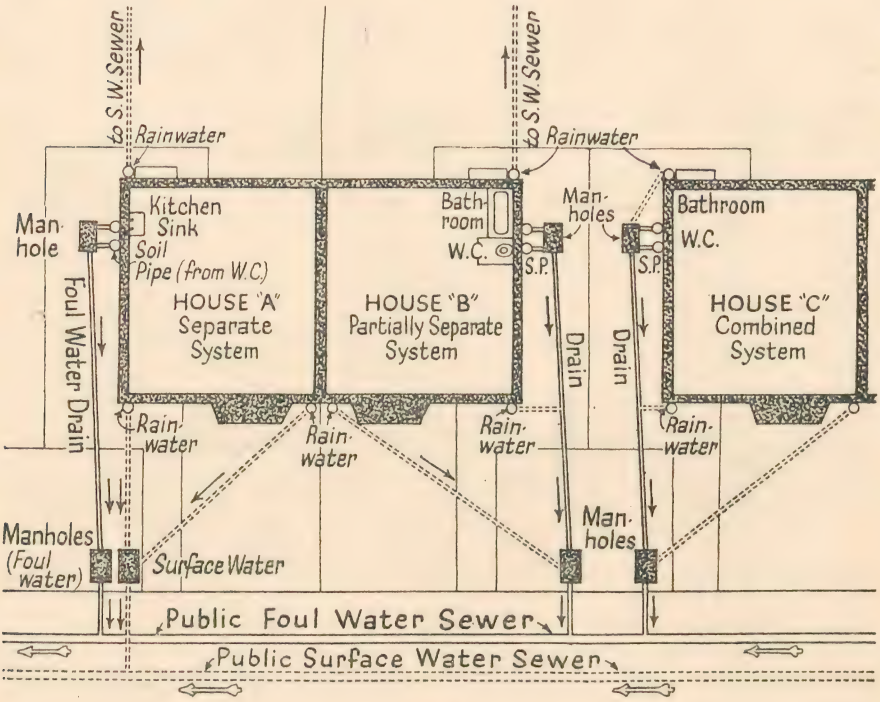


FIG. 1

combined system involves the least amount of pipework and is the simplest in layout. The choice of local system to be adopted is a matter for the Local Authority, and depends mainly on the method of treatment of the town's sewage at the sewage disposal works.

Information as to which system is in force will be available at the council offices.

Whichever system is adopted the underlying principles are much the same. At pipe junctions, and at bends in the drain lines, manholes with removable covers are provided. The course of existing drains can usually be followed by studying the

positions of such covers round the house. The pipes are laid in straight lines between the manholes, and at a sufficiently steep gradient to ensure that the contents flow away rapidly, and that solid matter is not left behind in the pipes. For all normal house drainage work pipes 4 in. in diameter are used; the fall must not be flatter than 1 ft. in 40 ft., but, of course, may be steeper. If the fall were less than 1 ft. in 40 ft. for a 4-in. pipe

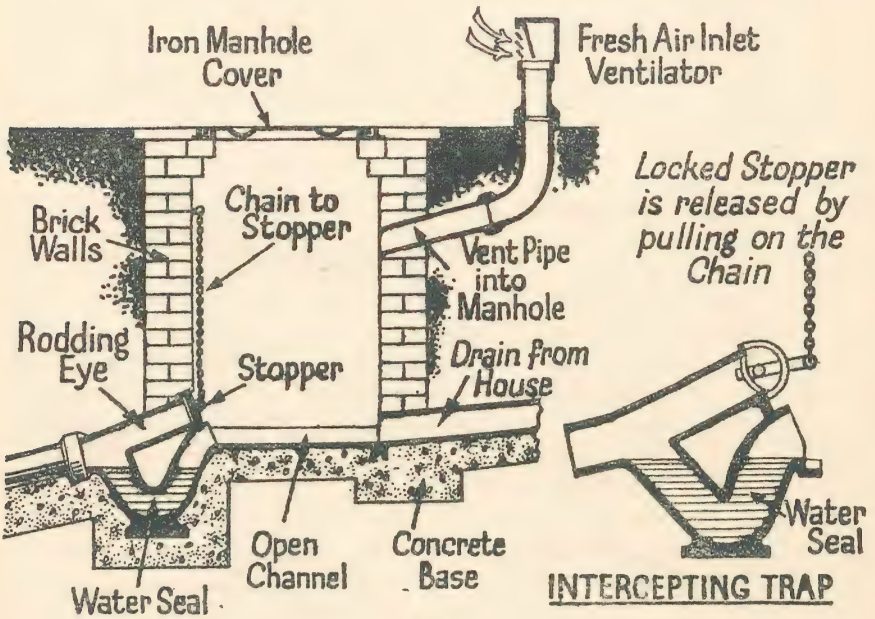


FIG. 2

solid matter would accumulate, and in the end the pipes would become blocked.

There may or may not be an "intercepting trap" in the final manhole before the drain passes under the property boundary on its way to join the public sewer. Intercepting traps are usually found in older property, but the practice of late years has been to omit them as unnecessary. The working and arrangement of the intercepting trap in its manhole will be clear from Fig. 2. It will be seen that the trap is provided with a rodding eye, so as to allow the length of pipe between the trap and the public sewer to be cleared by rodding should it become blocked. This rodding eye is provided with a stopper, and it is most important that this stopper should remain in position. If it falls out, or is lost, as is often the case, foul air from the sewer

can pass straight into the manhole and out of the cover into the air round the house.

Thorough ventilation of drains is essential, and for this reason the vertical soil stack to which the first floor wastes are connected is carried up above the roof eaves level to an open outlet from which foul air is carried away well clear of the highest windows. A wire guard is placed over the top of this pipe, and it is important that this should be kept in good condition. Otherwise birds may nest in the pipe and completely block the ventilation system. If an intercepting trap is provided there is also a fresh air inlet close to the manhole containing it. (See

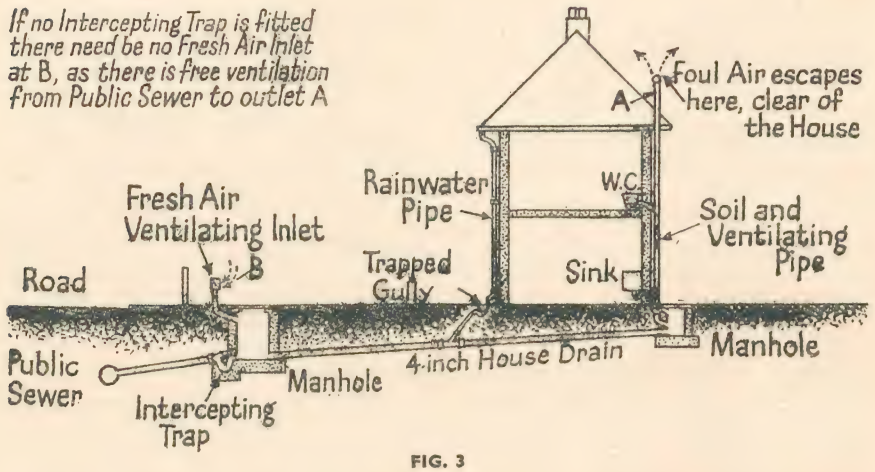


FIG. 3

Fig. 3.) The grating of this inlet can easily get blocked by the growth of weeds, and in course of time may even become buried. It must, of course, be kept clear or there will be no through ventilation for the drains.

Materials for drainage

Almost all domestic drains are laid in the familiar glazed earthenware socketed drain pipes, although occasionally the much more expensive cast-iron pipe may be used. Glazed-ware pipes of good quality, and properly laid, are perfectly satisfactory; only exceptional circumstances would justify the additional cost of cast-iron drains. There is a "British Standard" for glazed-ware pipes, and pipes to comply with this standard should be insisted upon for foul-water drains, for there are many unsatisfactory grades of pipe on the market.

Glazed-ware pipes are normally laid on a bed of concrete, more of which is afterwards "haunched" round the sides of the pipes, as shown in Fig. 4. In good firm ground the concrete is often omitted where local byelaws allow this. It is doubtful whether the saving in cost of omitting the concrete is really worth while. The pipes are laid with the sockets uphill, and jointed with a mixture of one part of cement to one part of sharp sand as shown in Fig. 4.

Manholes are built in brickwork on a concrete base. The method of construction is shown in Fig. 2. Common bricks

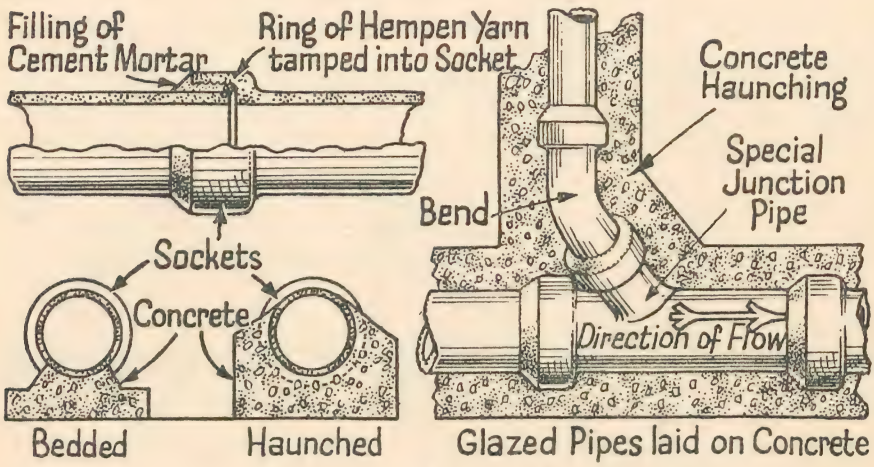


FIG. 4

should not be used for manhole walls, as these will disintegrate after a time under continuously damp conditions. Stock or "hard stock" bricks should be used. Strong manhole covers are important, and again the use of "British Standard" covers is a safeguard against inferior articles.

The vertical soil stack and its branch pipes should be in cast iron. Until recently cast iron was also universal for rain-water gutters and down-pipes, but today asbestos cement provides a very satisfactory alternative material which is widely used. Waste pipes from baths, sinks, etc., are usually in lead pipe.

Tracing out old drains

It is often not until something goes wrong that an attempt is made to locate buried drains round the house. In old property

especially this may not be easy. First a sketch plan should be made, showing all visible points of connection, gullies, manhole covers and so on. It should be borne in mind that manhole covers may have been buried during alterations, laying of new paths or construction of rockeries, etc. By pouring buckets of coloured water down the different gullies and sanitary appliances, and watching for the appearance of the water in the various manholes, it is usually possible to trace the general run of the drains. A useful colouring material for the test water is the chemical potassium permanganate, which can be bought at any chemist's. Dissolved in water it gives a deep reddish colour which is easily distinguished.

Testing for defects

Having traced out the run of the drains, all lengths should be tested for defects. A careful visual inspection combined with a note of the source of bad smells will often provide the required information. Accumulation of liquid in manhole channels will indicate partial or complete stoppage in the length of drain beyond. Damp patches on the ground may indicate a cracked or broken pipe beneath.

The thorough testing of drains with smoke or water is hardly a matter for the householder to carry out, as special apparatus is required. This work should be done by a builder or the Sanitary Inspector. While the visual inspection described may locate major defects, many others may be present, and a through testing of the drains should be undertaken.

A certificate that the drains have been tested, and defects, if any, have been made good, should always be asked for when purchasing or becoming tenant of a house. Naturally this is of particular importance in the case of old properties. A routine testing of the whole drainage system at regular intervals is a wise precaution and should be undertaken at intervals of say five years.

Drain stoppages

A stoppage in an underground drain is nearly always a matter for a builder or plumber to deal with. The use of a set of drain rods will be necessary; these consist of a series of flexible rods, which are screwed together end to end and pushed into the drain.

Various types of clearing tools can be attached to the end of the first rod, and the rods being worked to and fro, the stoppage is either broken up and dispersed, or pushed or pulled into the nearest manhole.

If the stoppage is sudden, and in a drain which has not previously given any trouble, it is most probably due to some large object such as a mop-head, brush or floorcloth having got into the drain and become wedged. Masses of newspaper are another frequent cause of stoppage. It is sometimes the practice to dispose of kitchen wastes, such as potato peelings, down an outside w.c. To do this is simply asking for trouble, because the house drains were never designed to deal with such material. Kitchen waste should find its proper place in the pig-food bin or humus-pit in the garden. Great care should be taken when cleaning w.c. pans to see that cleaning rags or brush heads are not allowed to pass into the drains by accident. Such objects, as well as kitchen waste and the like, may not cause an immediate stoppage, but will lodge somewhere in the system, forming an obstruction round which a complete stoppage will build up.

If the stoppage is partial—that is to say the retained liquid gradually seeps away—the cause is more likely to be due to a defect in the drain itself. One common cause of blocked drains is the entry of tree roots into the pipes. The rootlets of some trees and shrubs are so fine that it has been shown that they can pass even through the pores of a glazed-ware pipe, or more easily through a small defect in a joint. Once inside, the roots soon grow into a solid mass, completely blocking the drain. Relaying is the only remedy in such cases, especially as the pressure exerted by the growing mass of roots will probably have cracked or burst the pipes. The danger of damage to drains by tree roots is a very real one, and trees, or deep-rooting shrubs, should not be planted within 10 ft. of a buried drain. Poplars and the common privet are particular offenders in this respect.

Another possibility in the case of a partial stoppage is that the intercepting trap, whose function has already been described, is partially or completely blocked. Inspection often reveals that an intercepting trap has been more or less blocked for years; the sewage rises in the intercepting manhole until there is a sufficient head of liquid present to cause seepage through the obstruction. Clearance is effected by removing the stopper from the rodding

eye of the intercepting trap, when the retained liquid will pass into the sewer. Most intercepting traps are provided with a chain and locking ring arrangement (as shown in the illustration, Fig. 2), by means of which the stopper can be removed from ground level. If there is no chain it will be necessary to bale out the retained sewage in the manhole until the stopper can be reached. After the trap itself has been cleared and well flushed out, care should be taken to see that the stopper is securely replaced in the rodding eye.

Gullies and traps

Certain drain outlets from the house will be seen to discharge over a grating. In order to prevent the escape of sewer air through such gratings they are sealed by means of a trap, and the whole arrangement is referred to as a "gully." Typical arrangements of gullies are illustrated in Fig. 5. Few gully-traps are "self-cleansing," and a certain amount of sediment usually collects in the bottom of the trap. Periodically the grating should be removed and the gully flushed with a bucket or so of water containing a little disinfectant. This should prevent any possibility of stoppage building up in the trap. A blocked gully can usually be cleared by using a piece of stout wire, with the end bent in the form of a hook. It is most important that whatever material is blocking the trap should be removed altogether, and *not* pushed into the drain beyond. After clearing the blockage, swill the gully thoroughly with several buckets of water.

Gully gratings are frequently allowed to become very foul, and when in this condition cleaning them is a disgusting job. If the gratings are removed and cleaned at regular intervals—particularly the grating taking the discharge from the kitchen sink—the job is easy and inoffensive, and a common source of bad smells round the house will be removed.

In more recently built houses sink and bath wastes are usually connected into what is termed a "back entry" gully. This arrangement is shown in Fig. 5. The open grating is replaced by a removable inspection cover at ground level, fitted on the top of an extension piece to the gully itself. This arrangement is much to be preferred on sanitary grounds, and as time goes on it will probably become universal. A third arrangement,

still in the experimental stage, is for all wastes to be connected into a common stack which also takes the discharge from upstairs w.c.'s and acts as a ventilating stack. Here gullies are dispensed with entirely, and the arrangement is called the "one-pipe system." The system possesses several advantages,

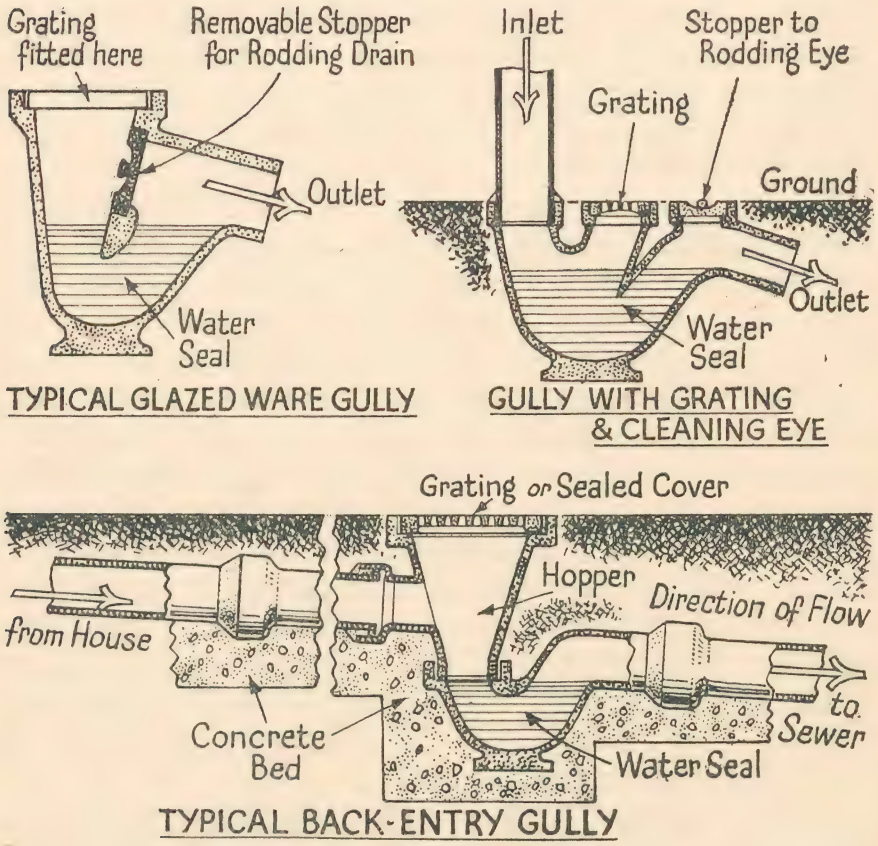


FIG. 5

but has not been widely adopted so far for houses in this country.

Rainwater pipes

Rainwater down-pipes usually discharge over a trapped gully in the same way as a sink waste. Exceptions are the occasional use of a back-entry gully for this purpose, and the use of what is called a rainwater "shoe"—which is really only a trapless gully. The three arrangements are illustrated in Fig. 6. Rainwater shoes are only used where the drains are on the separate system,

and the surface water drains have no connection with the foul sewers. Most authorities now agree that it is preferable that rainwater down-pipes should discharge into a trapped gully whatever the drainage system.

Rainwater gullies and shoes are particularly liable to become blocked. Pieces of rust from the inside of the down pipes, moss from the gutters, dead leaves and other debris all find their way into them. Regular inspection and clearance is therefore

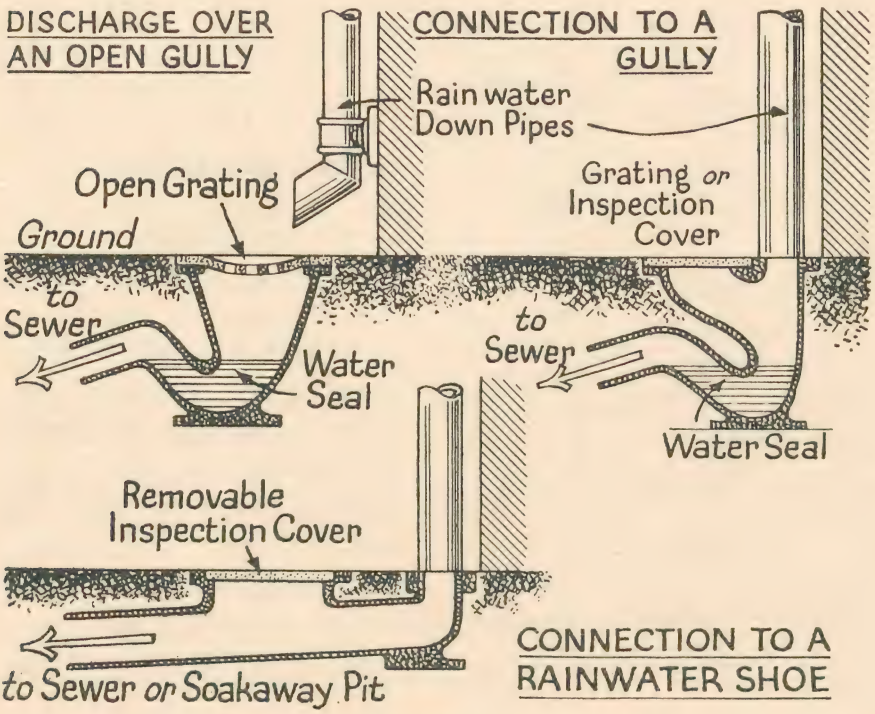


FIG. 6

very necessary, and should be made a routine job to be done say twice a year, in late autumn and early summer. Needless to say rainwater gutters at roof eaves level also need regular cleaning. Preferably this should be done yearly, and any defects found made good at the same time.

In a very dry summer it is possible for the contents of the trap in a rainwater gully to evaporate, thus allowing foul air from the drains to escape through the gratings or up the rainwater pipes themselves. It is a simple precaution to pour a little water into each gully during a prolonged drought.

Sink wastes and outlets

The arrangement of a typical sink waste is shown in Fig. 7. The waste pipe is practically always of lead, bent into the form of a trap as shown. The trap is not provided to catch debris which may pass down the waste, as many people seem to imagine, but to prevent foul air from the waste pipe from passing into the house. Owing to the presence of grease from washing-up, as well as particles of food, sink wastes easily become very foul, as well as being especially liable to blockage.

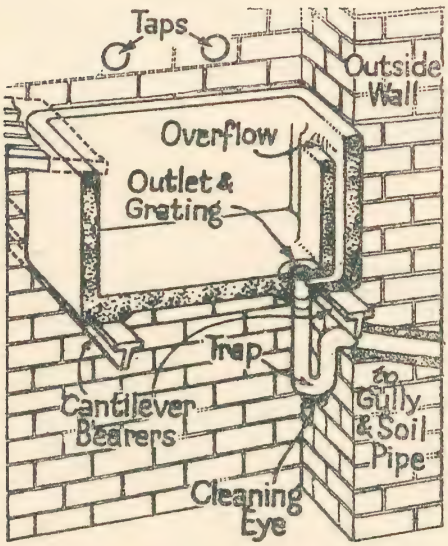


FIG. 7

From Fig. 8 it will be seen that a cleaning eye is provided at the lowest point of the trap. This is usually fitted with a castellated nut; great care should be taken in unscrewing this nut, as the use of excessive force may strain or break the lead waste pipe. A bucket being placed beneath the trap, the material causing the stoppage is removed, using a piece of stiff wire bent into the form of a hook. When replacing the cleaning eye plug, two or three turns of fibrous string should be wound round the threads so as to form a washer and prevent leakage.

A blocked sink waste may sometimes be cleared by means of a "force-cup." This consists of a stout dish-shaped rubber washer mounted on a wooden handle. Block the sink overflow with a dish-cloth, and placing the force-cup over the waste outlet in the bottom of the sink, plunge it sharply up and down a few times. This applies a hydraulic force to the obstruction in the waste-pipe of sufficient power to clear most stoppages. After clearance flush the waste with very hot water in which a *little* washing-soda has been dissolved. Caustic soda, or acids, should *never* be used to clean waste pipes.

Another important "don't" is, never attempt to clear a blocked waste by pushing anything down the waste outlet. Lead pipe

is soft, and such action is almost certain to result in a hole being pierced in the bottom of the trap.

Stoppages sometimes occur beyond the trap. If the use of the force-cup method fails to clear such a stoppage, a stiff but flexible wire should be gently inserted through the cleaning eye until the obstruction is felt. By working the wire back and forth the stoppage can be loosened, and then cleared by further use of a force-cup and by flushing.

A type of trap known as a "bottle-trap" is often fitted to

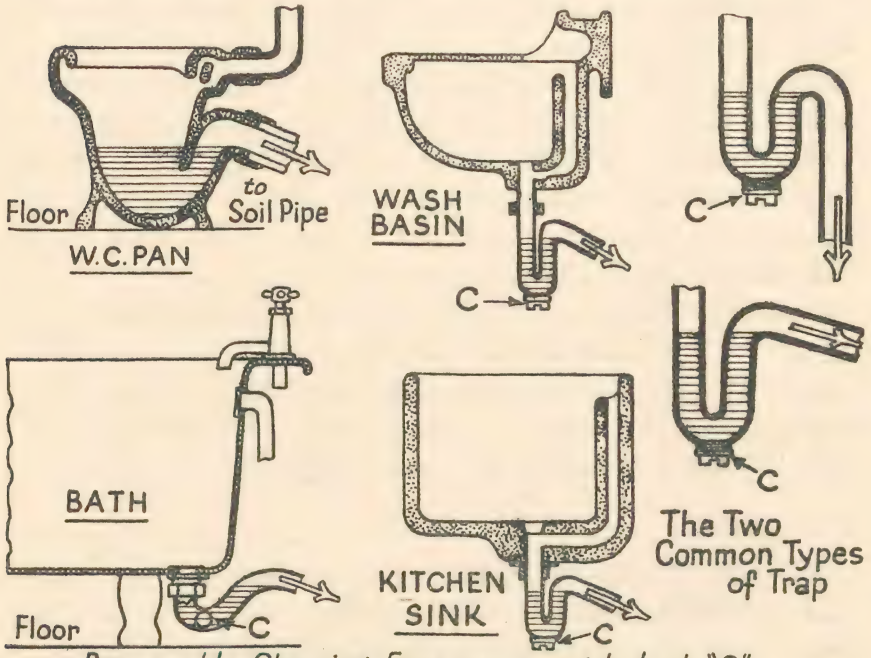


FIG. 8

waste outlets. Removal of the large hexagon nut on the base of the trap will usually allow the material causing the stoppage to drop out at once.

The Standard type of glazed-ware sink is provided with an open weir overflow, connecting with the waste through a channel cast in the body of the sink. Unless they are cleaned regularly such overflows become coated with grease inside and very foul. Cleaning should be done with very hot water and a suitable mop at regular intervals. The draining board should be arranged so as to be removable, to enable the rim and outside of the sink to be kept clean.

Baths and lavatory basins

Bath and basin wastes are trapped as sinks, and for the same reasons. If stoppage occurs, the same procedure as for clearing a stopped sink waste should be followed. Bath waste traps are often very inaccessible, and the cleaning eye may even be below floor level. Such an arrangement is a standing reproach to the builder, but is all too often found. In some post-war houses a trap-door is provided in the kitchen ceiling, through which access to the bath waste can be obtained.

Overflow pipes to these appliances are sometimes carried away separately, or may be connected into the trap of the main waste pipe. In some arrangements of plumbing a separate series of ventilating pipes is provided to bath and basin wastes. These prevent the water seal in the traps from being "drawn" by the suction of water passing down the waste, and are used particularly with the "one-pipe" system mentioned earlier. They should require no maintenance.

Where the local water supply is hard, high-water marks may appear on the inside of the bath, which, if they are allowed to remain for a long time, may become very difficult to remove. If the bath is wiped round frequently with a rag damped with a little paraffin it is easy to prevent this from happening.

W.C. pans

Blockage of the trap within a w.c. pan can occur, especially by large wads of paper, sanitary towels, and the like. If a stoppage does occur, it is most important that whatever material is causing it should be removed through the pan, and *not* forced through into the soil pipe, where it may well cause another stoppage which will be much more difficult to clear. Sanitary towels in particular can be the cause of endless trouble with drains. Even if they are claimed by the makers to be "soluble" they should not be put into the w.c. pan if any other means of disposal, such as burning, is available. It would not be necessary to utter a warning against the attempt to dispose of other kinds of refuse through the w.c., were not stoppages of drains so frequently caused by such misuse.

The joint between the outlet of the w.c. pan and the iron or lead soil pipe sometimes gives trouble by leaking. If a leak is found at this point the joint should be properly remade by a

plumber. Attempts at patching or stopping the leak from outside are always fruitless and may lead to very insanitary conditions.

Drainage in country districts

Where no public sewers are available the house drains will be carried to a cesspool or an arrangement known as a septic tank. Fortunately both are rapidly being abolished, but they still remain the only means of sewage disposal in many districts. It is not generally realized that neither a cesspool nor a septic tank is a means of sewage disposal without proper attention, and an attitude of "out of sight, out of mind" to either must lead to grave dangers to the health of the occupants of a house. Cesspools must be emptied at regular intervals, and it is not often that this job is undertaken by the local council. Even the best designed septic tank needs attention and occasional emptying of the sludge accumulated in the bottom. It is not possible to enter into the subject more fully here, but the householder who has either a cesspool or a septic tank on his property should seek proper advice on its maintenance in a sanitary condition. Again, there is no better place to go for such advice than to the sanitary officers of the local authority.

Various types of chemical closet are often installed in houses in remote districts. These can be perfectly satisfactory provided that the maker's instructions are strictly carried out. The buckets and pans should be kept scrupulously clean, and only the prescribed chemical fluids used for refilling. The best way of disposing of bucket contents is into a pit about 6 ft. deep as far away as possible from the house. In such a pit the solid contents of the buckets will settle out from the liquid, which will soak away into the subsoil under suitable conditions. At intervals the solid matter can be removed and used as a garden manure. Chemical closet contents should never be disposed of into ditches or streams; if this is done there is certain to be trouble from the water being made undrinkable for cattle, or from a river authority about pollution and damage to fishing.

CHAPTER XXI

ELECTRICITY SERVICES

About two-thirds of the homes in this country are now supplied with electricity for lighting, for power, or both. It is surprising that so many householders still seem to regard their electrical installation as a mystery, requiring the services of a skilled electrician whenever the smallest job has to be done. The shortage of skilled men to do such domestic jobs is likely to continue for a long time to come, and every householder should equip himself with the small amount of knowledge needed to keep his electrical system in good order and to carry out small additions to it to suit his own convenience.

Layout

The layout of an ordinary house electric system is very simple. The electric current is carried into the house either overhead or underground from the supplier's mains through a feeder terminating in a sealed box containing the company's service fuse. From here a wire passes to the *main switch* (by turning off which the whole supply to the house can be disconnected) and thence to the *distribution board*. On this board the wires divide into a number of separate *circuits* serving various parts of the house, and each provided with a *fuse*. In order to measure the amount of current used, a *meter* is provided, through which all electricity entering the house system passes. The whole arrangement is housed together in some convenient place, such as a cupboard or under the stairs. The functions of the various parts will be considered later, but first it is necessary to understand the meaning of a few technical terms.

Technical terms

Volts. The difference of electrical pressure, which causes an electric current to flow, is stated in *volts*. (To visualize this, think of the flow of water along a pipe caused by a difference of pressure between the two ends.)

Amps. The amount of electric current flowing is measured in *amperes*, nearly always abbreviated to *amps*. (Just as the amount of water passing in a pipe might be measured in gallons per minute.)

Watts. Is the measure of the rate at which electric energy is supplied to a *circuit*. The number of watts being used is given by the voltage multiplied by the current. Thus:

$$\text{Watts} = \text{Volts} \times \text{Amps}.$$

Unit. Is the abbreviation used for the standard Board of Trade Unit (B.T.U.) of electrical power used. This is 1,000 watts = 1 *Kilowatt* for 1 hour. Charges for electricity are based on Kilowatts (or B.T.U.'s) consumed, per hour.

Circuit. Electric current can only flow through a continuous path, such as a system of wires and filaments of electric fires. Such a path is called a *circuit*. If there is a gap made in a circuit, current will cease to flow; this is what happens when a switch is turned "off."

Ohms. Any circuit offers some resistance to the flow of electric current, depending on the materials composing it. This resistance is measured in *ohms*. To find the current that will flow round a circuit this simple law is used:

$$\text{Amps} = \frac{\text{Volts}}{\text{Ohms}}.$$

Supply systems

At one time electricity was supplied on pressures and systems varying all over the country. A standard has now been fixed by law which, for domestic supply, is a pressure of 230 volts, alternating current (A.C.), single-phase, 50 cycle. Phases and cycles need not concern us further here. Direct Current (D.C.) supplies, and voltages varying from 100 to 250 volts still exist in some places, but these are gradually being converted to the standard supply, which will end the present inconvenience to consumers.

Wiring systems

It is very necessary to protect the permanent wiring of the various electric circuits in the house from damage by damp or accident, as well as to isolate the live wires from the building itself. In high-class work this is achieved by the *conduit*

system, in which all the wires are enclosed in metal pipes or conduits, running under the floors or within the walls. The wires themselves are heavily insulated, and with such a system subsequent trouble is very rare indeed, even after many years of service. Should a breakdown occur in the permanent wiring system it is a matter for expert attention. A cheaper form of house wiring, often found in houses "built down to a price," is carried out in flexible *sheathed* cable, without conduit. The rubber insulated wire is encased in a sheath of lead or very tough rubber. This can be quite satisfactory, but is neither as safe or as long-lasting as the conduit method.

In old houses *wood casing* may be found in which the wires are run along the outside faces of the walls and covered with strips of wood nailed to the wall. This system does not come up to modern standards of safety and should be considered as a defect if a property is being considered for purchase. Even more undesirable is the old system of clipping the wires themselves to the walls without any protective covering, sometimes found where a house has been wired for electricity after it was built.

Whatever the system, the principle is the same, in that each lighting point, power plug, or fixed appliance such as a cooker, is on a separate circuit, connected either to the main distribution board or to what is called a sub-board. In the best work each circuit should have its own fuse, all fuses being grouped together in a box and labelled. Economy again often causes several lighting points to be served by a single fuse, with the obvious disadvantage that if this fuse "blows" many lights go out of action. In each circuit are placed one of more switches which make or break the circuit as required.

Circuits for "power" connections—as for electric fires, cookers, kettles and the like—have to carry heavier currents than lighting circuits and are therefore carried out in heavier wire. But the principle is exactly the same, and there is nothing to prevent a standard lamp, for instance, from being plugged into a power socket, if fitted with a suitable plug, as some people seem to imagine. Few houses, even of modern construction, are adequately served with power outlets. The ideal minimum is one lighting point, one 5-amp. and one 15-amp. wall sockets per room.

Fuses

To fuse means to melt, and sounds an alarming word, but this is exactly what fuses are intended to do. A fuse is a simple and effective safety device, protecting the house circuits from overloading, and cutting off the current if anything goes wrong. If there were no fuse in the circuit, overloading or a short circuit (a term we shall discuss under "Faults") would cause the wires to become hot, and even red hot, as do the filaments of an electric fire. For this reason it is *absolutely essential* to use proper fuse wire only when replacing a blown fuse. *Never*, even temporarily, mend a fuse with any other kind of wire. Mr. Ingleby Oddie, the famous London coroner, relates in his memoirs holding an inquest on five unfortunate women who were burned to death in a fire caused solely by someone having mended a fuse with a piece of thick iron wire. Less disastrous fires from this cause are all too common.

Fuse wire can be bought at any electrical shop, the usual grades being 5-amp., 15-amp. and 25-amp. It is easy to calculate the size of fuse wire which is correct for any circuit. Going back to the definitions of technical terms, watts = volts × amps., from which the current in the circuit in amps. must be the total load in watts connected to it divided by the voltage. Thus a 2,000 watt (or 2 Kilowatt) fire on a 230-volt supply would take a current of 2,000 ÷ 230, which equals 8·7 amps. A 5-amp. fuse would be too light, so the next heaviest—15-amp.—would be used.

Generally speaking, common sense will solve the problem, without the need for arithmetic. Lighting circuits, as the current is small, take a 2-amp. or 5-amp. fuse wire; the smaller power appliances, such as kettles, irons and small electric fires take 15-amp. wire; heavily loaded appliances, such as cookers and large fires, need 25-amp. wire.

If light or power fails on a particular circuit, examine the fuses, which are usually grouped together on the distribution board. Before touching anything, switch off the current at the main switch. Then take out the fuses one by one (supposing they are not already labelled for you) until one is found with a broken wire. Some blackening of the porcelain holder may act as a quick tell-tale. There are many types of fuse in existence, and the two commonest are illustrated in Fig. 1. Holders of

these types are called "bridges," because the fuse wire bridges across the porcelain insulator from the brass connectors at either end. Slacken the terminal screws and take out the old fuse wire. Wind one end of the new wire round one of the terminals and tighten it up. Then break off the length of wire required, thread it through the bridge, wind round the second terminal and tighten that also. Push the porcelain firmly back into

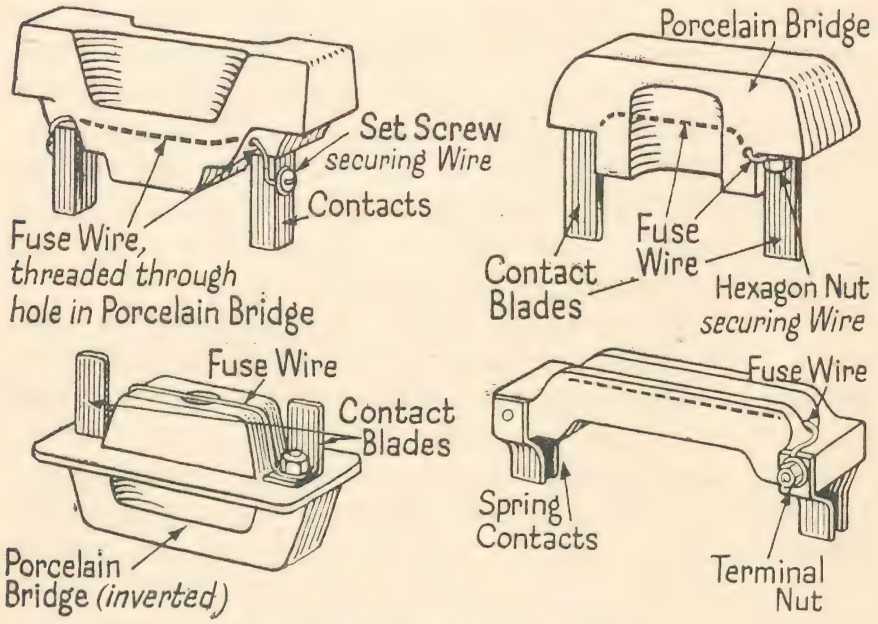


FIG. 1

place, switch on the main switch and test by observing the point which has failed.

If the fuse immediately blows again there is a fault in the circuit. Methods of dealing with this are dealt with below. The wire should not be drawn tightly across the bridge or it may break readily owing to expansion and contraction as the current is switched on or off.

Some old-type fuse-boards incorporate special fuse cartridges, and do not use fuse wire at all. In such boards it is only necessary to remove the blown cartridge and push in a new one. A supply of cartridges should be kept on hand as they are nowadays not easy to obtain in a hurry.

Under certain circumstances the main fuse to the house may blow instead of one of the individual fuses. This will cause all

the lights in the house to go out simultaneously. Procedure for replacement is the same. The main fuse bridge will be found inside the box housing the main switch; this box is always so arranged that it cannot be opened until the main switch is "off," as a safety precaution. Where the total loading in the house is heavy the main fuse may be divided—that is to say there will be two bridges side by side in the switch box—or there may be more than one main switch.

Tracing faults

As has been said faults in the permanent house wiring are very uncommon. Therefore, when a fuse blows, or an appliance will not work, it is almost certain that the fault lies within the appliance itself, or in the "flex" connecting it. There are two kinds of fault in wiring circuits, "short circuit" and "open circuit." They are best dealt with separately.

Short circuit. Here the current is not following its proper path, but is getting round the circuit by a shorter route; this causes the current to increase and blows a fuse. Where a fuse has blown therefore a short circuit should be suspected. The most usual causes of short circuit are as follows:

(*a*) Perished or frayed insulation in the flex connecting the appliance, allowing the two metal conductors to touch.

(*b*) Frayed ends of wire inside connector or plug, touching both terminals.

(*c*) Breakdown of insulation inside the appliance.

Open circuit. There is a gap in the circuit, so that current cannot pass round it. The appliance is "dead" and will not work, although current is switched on and fuses in order. Usual causes of an open circuit are:

(*a*) Terminal connections having worked loose in connector or plug.

(*b*) Break in connecting flex (which may not be visible on inspection).

(*c*) Break in element or filament within the appliance.

(*d*) Faulty contacts within controlling switches.

Repairing faults

The first and essential rule is *always to disconnect the appliance completely from the electric supply, or to switch off the current at*

the main switch. Never "fiddle about" with the current on; electric shocks, even from domestic supply voltages, can be a serious matter.

Lighting circuits. First make a test with a bulb known to be sound. If this does not light on switching on remove the cover from the switch; two terminals will be seen, as shown in Fig. 2. Place the bared ends of a piece of *insulated* wire across the terminals as shown in the figure. If the bulb now lights, the switch itself is at fault. Switch off at the main switch and examine the terminal screws (which should be tight) and the contact blades which move as the switch is operated.

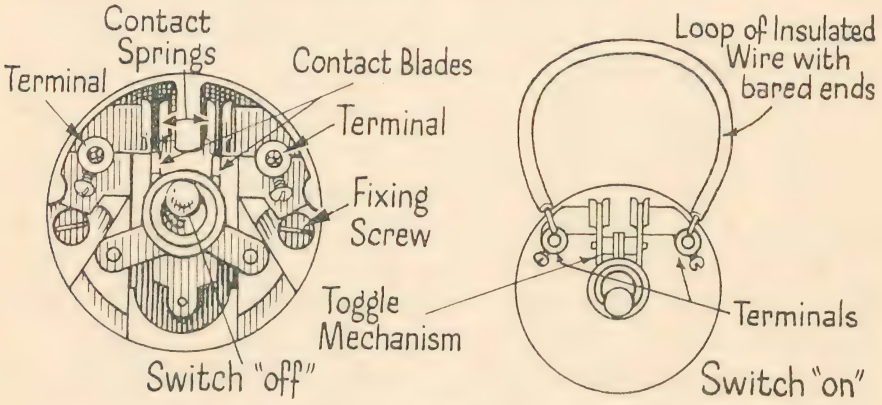


FIG. 2

The latter may be dirty or have sprung apart so that no contact is made; adjust them to make firm contact. If the toggle mechanism which operates the switch has come to pieces it is usually easier to fit a new switch than to attempt repairs. Remove the old switch by undoing the fixing screws and disconnecting the terminals. The two bare wires projecting from the switch baseboard are connected to the terminals of the new switch, which should be of similar type. In the case of flush fitting switches an exact replacement of the switch body will be required.

Flex connectors. If the switch is in order, suspect a fault in the connecting flex. Examine it carefully for internal breaks, or signs of heating due to short circuit. If either are found (or if it is old, frayed and worn) replace it completely with a new piece. *Never* try to repair it by twisting the bared ends of wire together and binding with "insulating tape," or to insert a new

piece in an old length by the same method. To do this is to ask for further trouble, and someone using the appliance may get a shock into the bargain.

If the flex seems in order take the connecting plug apart and examine the terminals. Faults here are usually obvious. The right method of preparing the ends of flex for connection to terminals is shown in Fig. 3. A loop should be made in the bare end of each wire as shown and the loose ends of insulation and fabric covering bound with insulating tape or thread to prevent subsequent unravelling.

Most plugs, and all hanging sockets and ceiling roses, contain *cord grips*, the purpose of which is to take the strain of any pull

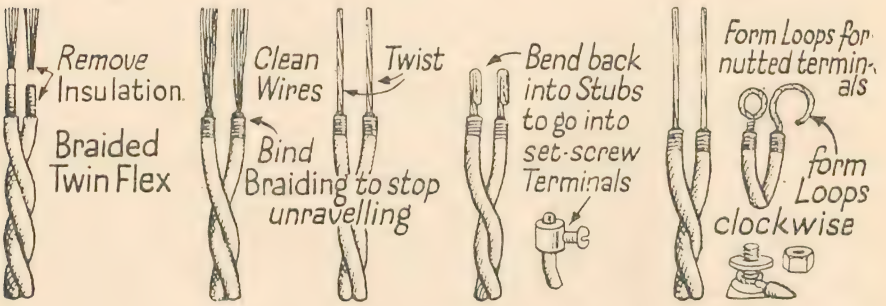


FIG. 3

on the flex off the terminals. It is most important that the flex is properly fitted through or round these grips. There are many varieties of grip, but a little study will show how most are intended to work. Common arrangements are shown in Fig. 4.

When reconnecting the flex make sure that terminal screws are quite tight and that there are no stray ends of wire about which might cause a short circuit from one terminal to the other. Make sure that the cord grip is holding the flex properly.

Flex connectors are easily damaged and have to stand hard wear. It is therefore a very false economy to use the cheap kinds which are often sold. Buy your flex from a reliable electrical shop and insist on good quality. For power appliances it is essential to use heavy grade flex, which has thicker wire to carry the greater current used.

Earth connections. All power appliances are (or should be) connected with flex containing a third "earth" wire as a safety

measure. Some electric supply authorities refuse to allow any other than the three-pin sockets for use with this type of connection to be installed in their areas. A short circuit inside an appliance, or in the flex leading to it, could cause the metal parts to become "live" and give the user a severe shock if any of them were touched. To prevent this the metal body of the appliance is connected to the third "earth" wire, which leads to the third (large) pin of the three-pin socket, and so conducts any accidental leakage of electricity safely away to earth. Any person using the apparatus is thus completely protected from any danger of accidental electric shock.

Flex connections to three-pin plugs are made as described

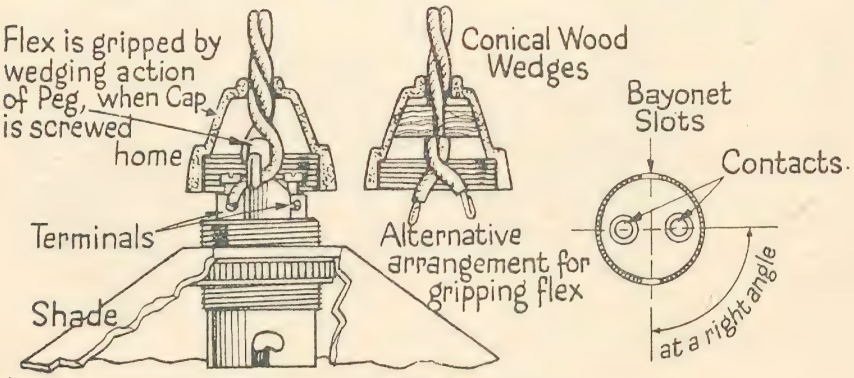


FIG. 4

above. The important thing is to make quite sure that the "earth" wire is connected to the right terminal. At the appliance end of the flex there will be a terminal connecting to some part of the metal body. As the coverings of the wires within a "3-way" flex are distinctively coloured, it is only necessary to see that the same coloured wire is connected to the large pin of the plug at the other end of the flex, as the one connected to this "earth" terminal. Never use a 2-way flex to connect an appliance such as an iron, omitting the earth connection. The appliance will work when so connected it is true, but the absence of a proper earth is highly dangerous.

Sockets and connectors. Failing the location of a fault in the flex connector or switch, carefully examine the socket or connector itself. In a lampholder there are two spring-loaded contacts designed to make contact with the two solder bosses on the base of the lamp; one of these may be sticking and failing

to make contact. These contacts must be at right angles to the slots for the lugs on the sides of the lamp base (see Fig. 4). See that the screw threads holding the parts of the lamp holder together are quite tight.

The pins of wall plugs are split, and if the plug seems loose in its sockets, these may be gently opened out with a knife blade.

Repairs to appliances

Unless you have a fairly clear idea as to how the appliance works, repairs should be left to an electrician. However, a careful study of the appliance after taking accessible parts to pieces will often show where a fault lies. It is not possible here to describe in detail the working of the many kinds of electrical appliance now in domestic use. Some hints and tips can be given for the maintenance of only some of them.

Cookers. The cooker should be kept scrupulously clean, particularly the hot-plates and the inside of the oven. These should be wiped over thoroughly after use and while still hot. Some makes of cooker have the top hinged or removable for cleaning purposes. This top should be lifted at regular intervals and all exposed parts cleaned. Rust may form on the undersides of hot-plates; this should be removed as far as possible with a stiff brush. Cooker repairs are outside the scope of the householder.

Kettles. Failure to operate (assuming connections are in order) means a faulty element. Renewal of this is an expert job. The kettle should be kept clean and scale removed from the inside at intervals, particularly from the heating element (usually seen as a ring close to the bottom).

If the kettle body is aluminium do not fill it with water from the hot tap. If there are copper pipes or a copper tank in the hot-water system minute amounts of copper will get into the kettle. A chemical action occurs between the two metals which can damage the kettle in a very short time.

Fires. Again failure to heat up is almost certainly due to a break in the special wire forming the element. This can often be seen on inspection. The wire is usually wound on a special asbestos or fireclay former, easily removable. Always take or send the faulty element as a sample for replacement. When

fitting the replacement make sure that it is connected exactly as before and that terminal screws are very tight. Coils of the nickel-chrome wire for heating elements can be bought; fitting them is not an easy job but may be attempted with the simple type of fire or boiling plate.

Irons. Some irons can be taken to pieces and a new heating element fitted, but in many modern types this is not possible and the appliances must be dealt with by skilled hands.

Vacuum cleaners. These should give little trouble if the attentions described in the makers' instruction book are carried out. Most makers have appointed service agents to whom the cleaner should be returned periodically for adjustment. It is important that the dust-bag should not be allowed to become too full or the machine may become clogged. Oiling is not usually necessary, as the internal bearings are packed with special lubricant which does not need renewal. Kept clean and carefully used a vacuum cleaner should give years of service without breakdown.

Refrigerators. It is important to see that the motor bearings are kept oiled according to the makers' instructions. Do not slam the door, even if there *is* a neat patent catch on it; if you do the hinges will be strained and after a time the door will fail to shut properly. Keep the interior scrupulously clean and defrost the coolant regularly as may be instructed. Adjustments are a highly skilled matter and should not be attempted.

Washing machines. Regular oiling in accordance with the makers' instructions is essential, but do not overdo it or oil may leak into the wash-water or on to the clothes. Always release the pressure on the rollers after use; there is a lever for this purpose. In very cold weather the bearings may be stiff, preventing the machine from starting properly; it is a good plan to fill it with *hot* water before switching on the motor—the heat will thin the oil in the bearings and allow the machine to run easily.

Other appliances. Space does not allow mention of the many other electrical appliances available for use in the home. All good manufacturers supply working instructions with their goods; see that these are exactly carried out, and keep them in a place where they can be easily found if needed. The words "misuse" and "neglect" cover 90 per cent. of faults occurring

in domestic electric appliances. Avoid these and the products of any reputable firm will give years of trouble-free service.

Use of Adaptors

Adaptors, giving two or three outlets to a single point, are easily purchased and are most useful gadgets, but a word of warning is necessary as to their use. It is easy by this means to increase the total load on a circuit to an unsafe level, particularly in the case of lighting circuits. Electric irons, boiling rings or small fires should *never* be connected to lighting points. Not only is there no provision for a safety earth lead (as described above) but heating of the circuit wiring may occur, particularly if a thicker fuse wire has been inserted to take the additional load. Fires can be caused in this way; investigation of one such case in a boarding-house showed that a load of over 3,000 watts had been connected to a lighting point by means of a system of adaptors.

There is no harm in connecting an ordinary wireless set to a lighting circuit, but radiograms, which sometimes use a lot of current, should preferably be connected to a power point. Adaptors should have a separate switch incorporated for the added circuit. There is a very useful type, known as a bed-switch adaptor, in which the controlling switch is on the end of a separate length of flex and so can be hung in a handy position

It is easy to work out the total load on a circuit. Examples are given in the section on running costs below.

Lighting: Planning for efficiency. It is not very many years since electric lighting was an expensive luxury enjoyed by the few. With current as cheap as it is today there can be no excuse for continuing to regard it as such, but none the less there are still many people using lamps which are far too small to give adequate lighting standards, and who feel that in doing so they are being really economical. In fact, there could hardly be a more false economy. Eyestrain, over-tiredness and many domestic accidents can result from bad lighting; these can be far more expensive than years of small economies on current consumption.

In the average-sized home, a consumption of about six electricity units per week over the whole year should be sufficient to provide lighting on a generous scale. On a two-part tariff,

with current at something less than 1*d.* per unit, the weekly expenditure is almost negligible in comparison with the benefits to health and well-being which good lighting brings. Even on a flat-rate tariff, with current at say 6*d.* per unit (a high rate) the weekly cost of good lighting need not be much more than the present price of a packet of cigarettes.

It is impossible to give a table of the minimum sizes of lamps to give adequate lighting in different rooms, because this depends so much on the type of fitting chosen, the colour and finish of the walls and the furnishings. However, the first requirement is that it should be possible for a person with normal eyesight to read small print (say the columns of a newspaper) in any part of the room without a feeling of strain. In most rooms this result can be achieved by a single fixed lighting point with a 100-watt lamp. The best type of fitting for such a fixed point is one which throws most of the light on to the ceiling, from which it is diffused over the whole room. Many types of hanging fitting which achieve this result are available; another satisfactory type is that in which the lamp is entirely enclosed in an opalescent glass globe, diffusing the light evenly over the whole room. Such general lighting will give a pleasant warm effect to the room. Fittings to be avoided are those which throw a circle of bright light downwards (usually on to a dark carpet or table top) and leave the rest of the room in shadow.

The centre of attraction in a living-room is the fireplace for a large part of the year, and a second and movable light should be arranged to serve this area, and give good light for reading, sewing and so on. A standard lamp, with a shade throwing most of the light downwards, is probably the best for this purpose, although some people prefer wall brackets over the mantelpiece. These are usually too high to give adequate light at chair level. The advantage of a standard lamp is that it can be moved to give a good working light at the point where it may be most needed under varying circumstances.

Avoiding glare

This is perhaps the most important principle of all in domestic lighting. Nothing can be more tiring than to sit under a glaring fitting, throwing its light downwards and creating shadows in the corners of the room. As a general principle it should not

be possible for the eye to fall direct on the lamp itself from any position; the filament is a point of extreme brightness which can cause injury to the eyesight after quite a short time. When people complain that the lighting in a room is too "glaring" the remedy is not to fit smaller lamps, and cut down the amount of light, but to fit a shade or fitting which will cut out the glare.

Kitchen lighting

Good lighting is particularly important in the kitchen, and in the average house is perhaps the place where it is least often found. There should be a special light over the cooker and sink, as well as a central light point for the rest of the room. Avoidance of glare is especially important in kitchen lighting; the best type of fitting to use is the enclosed opalescent globe. Special kitchen fittings of this type can be bought which are also dust and moisture proof. The old type of opal glass cone-shaped shade should never be used in a kitchen, and indeed should be regarded as obsolete everywhere else. Such fittings not only shade the light from the ceiling, from which it can diffuse pleasantly over the room, but seem to have been especially designed to give the maximum amount of tiring glare.

Bathroom lighting

The same standard of lighting is required in the bathroom as in the kitchen, and a similar type of enclosed opalescent fitting is the most satisfactory.

Bedroom lighting

The best arrangement is a soft diffused fixed lighting point, combined with a bedside lamp standard. Any trace of glare is particularly trying to a person lying in bed. A soft effect should be aimed at, and this can often be obtained by using a coloured fitting which does not throw too much light on the ceiling.

Guide to lighting efficiency

Assuming that the principles we have outlined are carried out, the following table may be a useful guide to the sizes of lamps required to give an adequate standard of lighting. (By an "adequate" standard is meant one which scientific measurements

have shown to be sufficient for domestic activities to be carried on without eye strain and tiredness.) The table is based on the floor area of the room in square feet and gives the number of watts illumination normally required per square foot.

Type of lighting.		*Watts required per sq. ft.*
Diffused, throwing light *upwards.*	Living-rooms ..	1½
,, ,, ,,	Bedrooms	1
Diffused, throwing light *downwards.*	Living-rooms ..	¾
,, ,, ,,	Bedrooms	½
,, ,, ,,	Kitchens	1½
,, ,, ,,	Passages, etc. ..	¼
Diffused, throwing light all round.	Living-rooms ..	1
,, ,, ,,	Bedrooms	¾
,, ,, ,,	Kitchens	1–1½

Thus suppose we have a living-room 15 ft. by 12 ft. in plan. The floor area is 180 sq. ft. To get the *total* wattage of the lamps required to light the room adequately we must multiply the watts per square foot factor given for the type of lighting used by 180.

Care of light fittings

To obtain maximum efficiency it is most important that lamps and fittings be kept clean. Lamps should be removed periodically and washed in warm soapy water, being carefully dried before being replaced. Fittings should be kept clean and free from dust. It is surprising how much light can be lost by neglect of these simple precautions.

Reading the electric meter

Reading the meter is very simple. The usual arrangement of dials is shown in Fig. 5. The dials register units, tens, hundreds and thousands of units used, and are so labelled. The small dial (usually coloured red) is for testing the meter and can be neglected. On some meters there is an additional dial reading in tens of thousands of units. Read the left-hand dial first; the pointer will lie between two figures—write down the lowest of these. Here the figure is 6. Do the same with each of the other dials, working towards the right and ignoring the smallest

dial marked $\frac{1}{10}$ kWh. If a pointer is exactly over a figure still write down the next lowest, *unless* the dial on the right of it is reading 0, when the figure indicated is the correct reading. The meter in the illustration is reading 6,937 units.

To find the amount of current consumed since the meter was last read, deduct the last reading (recorded on the meter card) from the figure obtained. If the last entry on the meter card

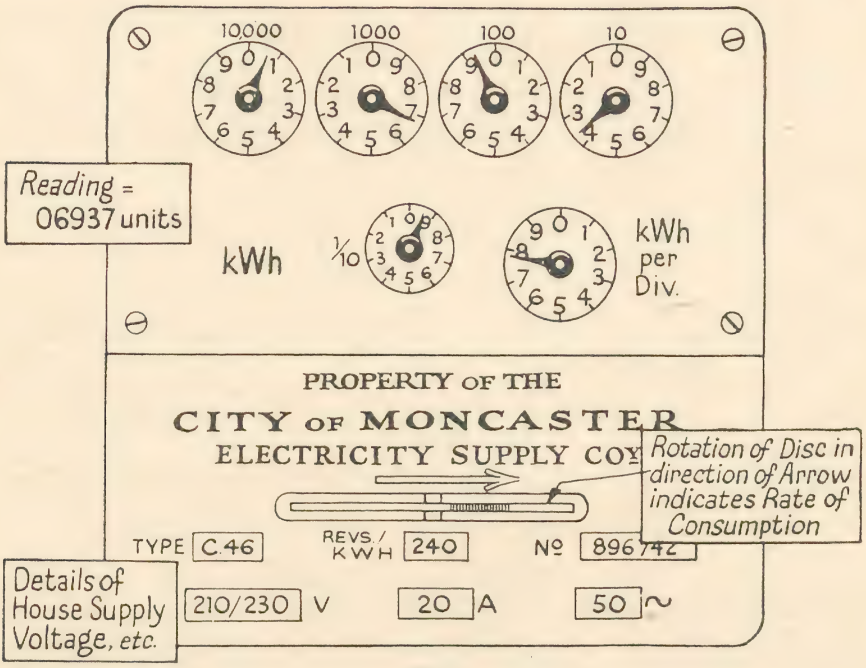


FIG. 5

showed, say, 6,822, 115 units would have been used since the last reading.

Calculating running costs

The cost of running any appliance is simply its load in kilowatts multiplied by the price charged per unit for electricity for every hour run. For example (and remembering that there are 1,000 watts in a kilowatt) the cost of running a 100-watt lamp at 5*d*. per unit is

$$\frac{100}{1{,}000} \times 5 = \tfrac{1}{2}d. \text{ per hour.}$$

In the same way a 2-kilowatt fire, with current at $\frac{3}{4}d$. per unit would cost

$$2 \times \tfrac{3}{4} = 1\tfrac{1}{2}d. \text{ per hour.}$$

Lamps and appliances are usually marked with their loading in watts. On most appliances the loading will be found stamped on a plate giving other particulars, such as the makers' type and number and the working voltage. Sometimes the loading is stated in amps. current at a certain voltage. If this is so the wattage is easily calculated by multiplying the rated amps. by the voltage. For instance, a kettle rated at 3·2 amps. at 230 volts would have a wattage of

$$3{\cdot}2 \times 230 = 736 \text{ watts.}$$

The following table is a guide to the consumption of typical lamps and appliances at the standard supply voltage of 230 volts:

Lamps:

Watts.	*Hours running for 1 electricity unit.*	
15	66	
25	40	For the consumption of a number of lamps add up the total wattage and divide into 1,000.
40	25	
60	16½	
75	13½	
100	10	

Appliances:

Type.	*Wattage.*	*What 1 electricity unit will do.*
Fire: 1 bar	1,000	Operate for 1 hour.
2 bar	2,000	„ ½ hour.
3 bar	3,000	„ 20 minutes.
Cooker, average size.	Total load about 5 kW.	Cook a full meal for 4 persons.
Kettle, 3-pint.	750 to 1,500	Boil 5 times.
Radio.	60 to 200	Operate from 5 to 15 hours.
Vacuum cleaner.	100 to 200	Operate from 5 to 10 hours.
Iron.	500 to 750	Operate from 1½ to 2 hours.
Washing machine.	200 upwards	Operate for 5 or less hours according to size.

The cost of electricity depends on the consumers' tariff. Most suppliers in these days operate what is called an "all-in" rate, at which current is supplied very cheaply (usually at less than 1*d*. per unit) plus an annual payment based on the rateable value of the property. This tariff is deliberately designed to encourage domestic consumption of electricity, and for purposes other than lighting only is advantageous to the consumer. Full details of the local scheme will be available at the supply authorities' office. Great reductions in domestic charges have

been made over the past twenty years, the average rate charged over the whole country now being about $1\frac{1}{2}d.$, as compared with nearly 6*d*. per unit in 1922. Whatever the present local charges are, the economics of installing any particular appliance can easily be worked out by using the rules given above.

Future developments

It is probable that there will be far-reaching changes in methods of house wiring and installation in the next few years. Government committees are studying the adoption of a single standard type of wall socket to suit all domestic appliances, which would do away with the present confusion between 5-, 10- and 15-amp. outlets. The proposed standard plug would incorporate a simple fuse of the cartridge type which would make groping round inaccessible fuse-boards in the dark a thing of the past. A much simpler and cheaper form of permanent house wiring is also proposed.

Great improvements over pre-war models of all appliances have already been made, and it is certain that electricity will be applied in many new ways to lightening the work of the home.

A word of warning

In conclusion, a word of warning is necessary to the householder who intends to carry out repairs or extensions to his electric supply system. This is against the use of cheap-grade sockets, switches, adaptors and the like. The cheap and nasty switch bought at the multiple store is not "just as good as" the standard grade article at three times the price from a reputable electrical dealer. Most such articles defy every rule laid down by the industry for the protection and safety of the public and may well become a source of danger in the home. The same applies in even greater degree to cheap flex with its thin and perishable insulation. There are British Standard grade articles for every household electrical use, and it is is a very sound economy in the end to insist on these.

Most supply authorities reserve the right to refuse or cut off a consumer's supply if they are not satisfied with the safety of the house wiring. If the cheap and shoddy materials to which we have referred have been used they would be quite in order in

exercising their right in this connection. In electrical goods, as in many other matters, "it pays to buy the best," and the words "British Standard" or the letters "B.S." are there to protect the purchaser. It is illegal to apply them to any article not coming up to the high quality laid down, and they are worth looking out for.

CHAPTER XXII

GAS SERVICES

It has been estimated that about five out of every six families in Britain have a supply of gas to their homes. Nowadays the majority use gas only for cooking and heating; for lighting purposes it has largely given place to electricity. In recent years the quality of gas has been much improved and modernized and more efficient appliances have been introduced. The repair of faults in the domestic gas service is largely a matter for the skilled gas-fitter, but there are many points which should be understood by the householder so that the system may be kept in first-class order.

Layout

Gas is supplied to the house through a branch pipe from the company's main, known as the "service" pipe. This is usually 1 in. in diameter for a house of ordinary size, in order to ensure an adequate supply of gas at good pressure, and is normally the responsibility of the gas company to maintain and repair. The service pipe ends at a stop cock inside the house, situated just before the gas meter. The location of the meter varies, and it is often found in most inaccessible positions. In modern houses it is usually housed in a special compartment, also containing the electricity meter and main fuses.

From the stopcock onwards the distribution pipes carrying gas to different points in the house are the responsibility of the householder; these are sometimes called "installation pipes," and vary in diameter from $\frac{3}{4}$ in. for a normal cooker down to $\frac{1}{4}$ in. for lighting points. It is most important that the location of the main gas stopcock should be known to everyone in the house, so that it may be turned off without delay in the event of escape of gas or fire. For the same reasons, if the stopcock is operated by a removable key, this key should always be kept in position on the cock ready for use, and preferably wired on, so that it cannot be accidentally removed and lost. Try the

stop cock occasionally to make sure that it operates freely. If it is very stiff draw the attention of the gas-fitter to it next time he visits the house. The usual location of the stopcock, and its "on" and "off" positions, are shown in Fig. 1.

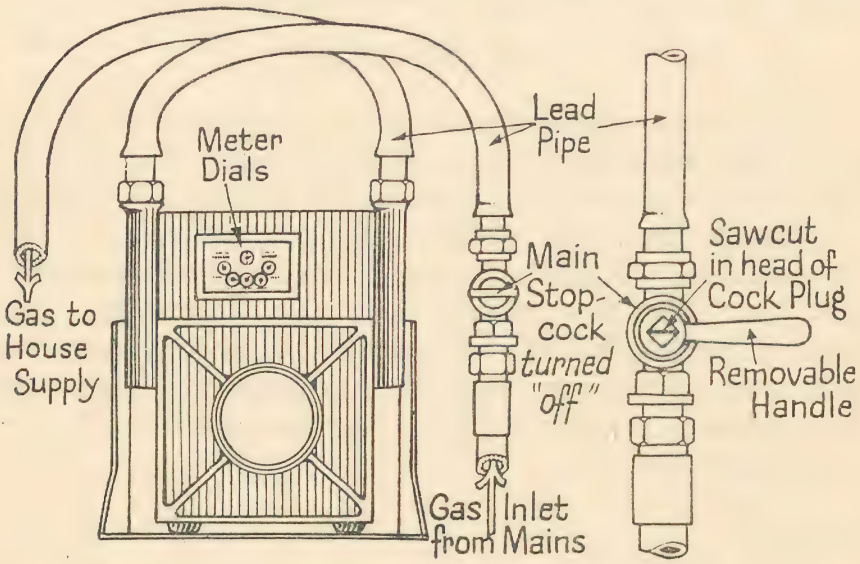
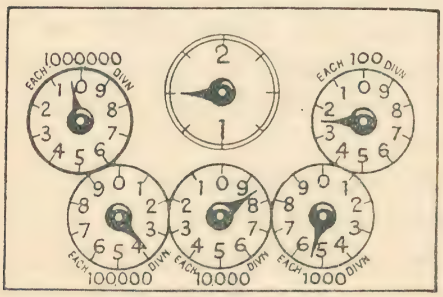


FIG. 1

Reading the gas meter

The meter measures the amount of gas consumed in cubic feet, and the dials are arranged in much the same way as on the electricity meter, as illustrated in Fig. 2. The left-hand dial registers millions of cubic feet, and from left to right the others register hundreds, tens and single thousands. The small dial at the top is only used for testing the meter and should be ignored. Beginning with the left-hand dial, write down the smaller of the figures between which the pointer stands. Do the same for the other three dials, add two noughts to the answer, and you have the reading of the meter in cubic feet. If a pointer is exactly over a figure, still write down the next lowest, *unless* the dial on its right is reading 0, when the figure indicated is the



Reading = 385,200 cubic feet

FIG. 2

correct reading. The meter in the illustration is reading 385,200 cubic feet.

How gas is charged for

Some gas companies still charge directly at so much per thousand cubic feet of gas used, but the majority today base their charges on a unit known as a "therm." The therm is a measure of the actual heating value of the gas supplied, which varies considerably in different areas. The "therm" system is much fairer to the consumer, who pays for the actual heat he can get out of the gas supplied, and not merely on its volume. Where charges are made on a basis of therms, the gas company is compelled by law to maintain the heating value of its gas at not less than a declared value, and the gas is subject to test from time to time to make sure that this is being done. To convert cubic feet (read from the meter) to therms the following equation is used:

$$\text{Therms} = \frac{\text{cubic feet} \times \text{calorific value per cube foot}}{100{,}000}.$$

The calorific value of the gas per cubic foot is usually stated on the gas bill; normally it varies between 450 and 550 standard heating units (B.T.U.'s) per cubic foot. Thus a consumer whose meter showed that he had used (say) 8,000 cubic feet of gas in a quarter, a calorific value of 500 would be charged for:

$$\frac{8{,}000 \times 500}{100{,}000} = 40 \text{ therms}.$$

Charges for gas vary greatly in different parts of the country—from less than 3*s*. to over 8*s*. per thousand cubic feet, and from about 6*d*. to 1*s*. 6*d*. per therm. It is therefore wise when settling in a new district to ascertain the local price of gas as compared with electricity before deciding on the use of one or the other for cooking and heating.

Escapes of gas

Even a small leakage in the gas supply is given away at once by its smell. As gas is both a dangerous poison and highly explosive when mixed with air, an escape must *never* be neglected. If it is serious, turn off the supply at the main stopcock, open all the windows and doors to get a draught through the house and

send for the gas company's fitter at once. It should not be necessary to warn against searching for a gas leak with any kind of naked light, were it not for the fact that so many serious explosions and accidents have been caused by this means. If a light is necessary use an electric torch. The most likely places for leaks to develop are in taps or at joints in exposed supply piping, particularly where this is exposed to accidental knocks. The best way to test for a suspected but invisible leak is to cover the suspected part with a film of wet soap; bubbles will form round the point at which gas is escaping.

A small leak in a pipe or joint may be temporarily stopped by covering it with soap, afterwards binding round with insulating tape. Leaks in control taps are usually due to looseness. There is a small nut at the base of the tap which should be *gently* tightened. This will hold the moving part of the tap more firmly on its seating and may cure the trouble. Do not regard any repair of the kind described as other than temporary, pending permanent attention by a gas-fitter. Connections to gas fires are usually made in copper pipe, jointed with a hexagon brass union nut. If leakage at this joint is suspected, the nut should be tightened with a spanner.

Leaks inside burners or appliances are very unusual. If they do occur the faulty appliance should not be used until it has been properly attended to by a gas-fitter.

Adjustment of burners

All modern gas burners are arranged to burn a mixture of gas and air, and it is essential that the mixture be in the correct proportions for the burner to work efficiently and give full value in heat for the gas consumed. Air is admitted to the pipe just before the burner, and there is usually an arrangement for adjusting the amount of air drawn in. A properly adjusted gas flame should consist of an inner cone of intense blue colour, and a second cone enveloping the first of reddish or mauve colour. The flame should burn steadily and without undue noise. A long yellowish flame without distinct cones means too little air, while a short flame, more or less all blue in colour and burning with a "roar," means too much air. In either case combustion is inefficient and the gas used is not giving its value in heat.

If gas burns with an unpleasant smell it usually means too

little air, or the burner itself may be dirty. There is always some small deposit round a gas burner, and this should be removed periodically, using a small stiff brush.

Lighting fittings

Modern lighting fittings should give little trouble and only need occasional attention. Correct air-gas mixture is important. Adjustment should be made to give maximum brightness of the mantle, and, once made, should not need alteration if the fitting is cleaned occasionally with a small brush. A modern development has been "switch-on" gas, in which the tap is situated at some convenient point on a wall or near the door, and the burner is ignited by means of a continuously burning by-pass. Such fittings are rather delicate in adjustment, and it is best to have them attended to by a gas-fitter if they do not work properly.

Gas mantles today are much more robust than the products of a few years ago and should give long service without breaking. A broken mantle should be replaced at once, because flame escaping through the break may soot up the fitting or break glass shades or globes by overheating them.

Care of appliances

Cookers. It is sometimes said that gas cookers are difficult to keep clean, but this is quite untrue if regular attention is given to cleaning. The interior of the oven should always be wiped down thoroughly after using, and while it is still warm. If this is done the deposit of grease, which can be so difficult and unpleasant to remove once it has formed, will not occur. Removable parts, such as shelves, should be taken out frequently and washed in very hot water containing a little soda, and thoroughly dried before they are replaced. Oven doors are usually removable by merely lifting off their hinges. The door should be taken off from time to time and the opening and hinges cleaned. Keep the burners at the bottom of the oven clean by brushing with a stiff brush and see that the holes do not become blocked by pieces of foreign matter.

In modern cookers the grid-bars and burners are removable. Lift out all removable parts from the top of the cooker regularly and clean thoroughly. Make a careful note of the order in which the various pieces go back and see that they are replaced

correctly. Grill frets are liable to become rusty. They should not be washed but brushed with a stiff brush to remove rust and dirt. Never clean enamel parts of a cooker with abrasive soap powders; they will scratch the hardest enamel after a time and spoil the finish.

The flames from boiling ring and grill burners should have bright blue inner cones about $\frac{1}{2}$ in. long. If kept thoroughly clean no adjustment should be needed. Flames should not project beyond the bottom of the utensil being heated; to allow them to do so wastes gas without heating the utensil any more quickly.

Fires. Once correctly adjusted these should need very little attention. The gas should burn quietly, with the radiant elements glowing evenly and brightly. Flames should not project over the top of the radiants. "Roaring" means too much air; yellowish flames, and blackening at the top of the radiants, means too little air. If the fire "lights back" turn if off and wait for about 15 seconds before relighting. If this trouble is frequent the fire should be examined by a gas-fitter.

Gas-coke fires. These are designed to burn gas and coke together, and usually to act as an open fire or a closed stove, as required. They burn very little coke and give an intense heat. The maker's instructions as to cleaning and removal of ash should be followed exactly, and no fuel other than the type of coke recommended should ever be used.

Radiators. There are two main types, in the first of which water is heated by low gas flames. The heated water circulates through gills similar to those of an ordinary radiator. In the second type, the flame is made to heat a large area of iron casting, so arranged that the outside does not become dangerously hot to touch. Both types are very useful for heating halls and stairways, and in such positions are a very economical means of warming the house.

Gas pokers. A gas poker should last for years if not misused. Never leave it in the fire for longer than is necessary to ignite the fuel, and keep it thoroughly clean, with particular care to see that the burner holes do not become partially or completely blocked.

Refrigerators. Beyond following the maker's operating instructions, adjustment of gas-operated refrigerators is a skilled matter and should not be attempted by the householder.

Running costs

Owing to local variations in the heating power (calorific value) of gas supplied, and to variations in design of equipment, it is not easy to estimate running costs of gas appliances. The following is a table of the *approximate* consumptions of gas in cubic feet per hour of typical modern appliances:

	Consumption of gas. Cubic feet per hour.
Cooker: Oven full on	30–40
Hot-plate burners, each	25–35
Fire: 3-panel	20–40
Portable	10–15
Radiator	5–10
Refrigerator, average through year	2
Geyser, to heat average bath	20–30
Storage water heater, 20-gallon, with average draw-off	20–25

These figures are very general and intended only as a rough guide. Cubic feet can be converted as therms described above.

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